# CHAPTER XX

(RESERVED)

(EMERGENCY PREPAREDNESS FACILITIES)

To be issued

# CHAPTER XXI

# PLUTONIUM PROCESSING/HANDLING FACILITIES

## 1. COVERAGE.

Chapter I of this Order provides fundamental design requirements for DOE facilities, and subsequent Chapters II through XV provide more specific criteria which is discipline-related. Other DOE Orders cited therein provide specific safety criteria for facilities handling radioactive materials, to be applied in the planning, design, construction, and operation of such facilities. This Chapter supplements these other sources, and provides specific direction and guidance on particular requirements which must be met in the design and construction of facilities for processing and handling of substantial quantities of plutonium. These particular requirements are necessary because of specific toxicological problems associated with plutonium. What constitutes a "substantial quantity" depends upon the specific processes and forms of plutonium involved, and will be evaluated for each situation under consideration.

a. The criteria shall be applied in the planning and design of new plutonium processing or handling facilities. They were originally developed in the Atomic Energy Commission during 1971 for specific application in the planning and design of the new Plutonium Recovery Facility (Rocky Flats, CO) and the new Plutonium Handling Facility (Los Alamos, NM). The term "substantial quantities of in-process plutonium," relates to these types of facilities. Subsequently, these criteria have also been effectively applied in the planning and design of other types of facilities where the research and development, engineering, fabrication, inspection, testing, or other activities involved plutonium in various forms and quantities.

b. These criteria shall continue to be applied in the planning and design of all such DOE facilities including facilities which involve other transuranic elements (in addition to mandatory application for any new DOE plutonium recovery or processing facility). However, deviations from certain portions may be appropriate and justified. Any such deviations will be based on an analysis of the safety evaluation of the facility, safeguards and physical protection requirements for the particular quantities of plutonium involved and operations to be performed, degree of need for operating continuity during and/or following postulated accidents, and other project-specific requirements. Questions on the application of these design criteria in the planning and design of new DOE facilities that involve plutonium or other transuranic elements should be addressed to the Director, Office of Project and Facilities Management and to the Deputy Assistant Secretary for Environment, Safety, and Health, EP-30, at DOE Headquarters, for resolution.

2. OBJECTIVES.

The objectives of these criteria are to assure that the design of the facility will:

a. Protect the public and operating personnel from hazards associated with normal plutonium operations or design basis accident (DBA) conditions, including the effects of natural phenomena pertinent to the site.

b. Assure compliance with DOE policies regarding nuclear safety, radiation safety, industrial safety, fire protection, pollution control, and security and safeguards protection for special nuclear material.

c. Protect government property and essential operations from the effects of potential accidents.

3. DEFINITION OF TERMS (for purposes of these criteria).

a. Confinement Area. The structures or systems from which releases of plutonium are controlled. The primary confinement systems are the process enclosures (glove boxes, conveyors, transfer boxes, other spaces normally containing plutonium) which are surrounded by one or more secondary confinement areas (operating area compartments).

b. Critical Area. Any area handling plutonium where the plutonium could be accidentally dispersed and cause exposures (in excess of limits set forth in Chapter XI of DOE 5480.1A) to either operating personnel or to the public.

c. Critical Items. Those structures, systems, and components whose continued integrity and/or operability are essential to assure confinement or measure the release of radioactive materials in the event of DBA. Critical items shall be capable of performing required safety functions.

d. Criticality Incident. An accidental, self-sustained neutron chain reaction.

e. Design Basis Accidents (DBA). The postulated accidents and resulting conditions for which the confinement structure, systems, and components must meet their functional goals.

f. Design Basis Earthquake (DBE). (Equivalent to Safe Shutdown Earthquake (SSE).) That earthquake which is the most severe DBA of this type and which produces the vibratory ground motion for which critical items are designed to remain functional. These critical items are those necessary to assure the capability:

(1) As necessary to safely shutdown operations, maintain the plant in a safe shutdown condition, and maintain integrity of the final confinement barrier of plutonium.

(2) To prevent or mitigate the consequences of accidents, or to monitor releases which could result in potential offsite exposures, determined in accordance with paragraph 6a, below.

g. Design Basis Tornado, Explosion or Criticality. The most severe DBA of that type applicable to the area under consideration.

h. Design Basis Fire (DBF). That fire which is the most severe DBA of this type. In postulating such a fire, failure of automatic and manual fire suppression provisions shall be assumed except for those systems considered critical items.

i. Enclosure. A primary confinement system such as process systems, glove boxes, conveyors, hot cells, and canyons.

j. Facility Boundary. The fence which surrounds and prevents uncontrolled access to the facility or facilities.

k. Fail-Safe. A design characteristic of a unit or system which, in the event of a failure of a component or loss of its activation energy, will move to a safe condition and remain safe.

l. Operating Area Compartment. An area or series of areas which contain process enclosures, and/or their attendant equipment located within that area or series of areas.

m. Operating Basis Earthquake (OBE). That earthquake which produces the vibratory ground motion for which the plant structure, systems, and components are designed to either remain operable or be readily restorable to operating condition. The OBE is equivalent to at least one-half the DBE in terms of ground acceleration. (See American Nuclear Society Standard ANS 2.1, "Guidelines for Seismic and Geologic Investigations to Determine the Operating Basis Earthquake and Associated Vibratory Ground Motion.")

n. Plutonium Facility. Any facility constructure primarily to process plutonium (including a $Pu^{238}$) and which handles substantial quantities of in-process plutonium where there is a possibility of a release of plutonium to the environs under normal operations or DBA conditions in excess of limits set forth in Chapter XI of DOE 5480.1A.

o. Site Boundary. The perimeter of the DOE-controlled land in which the facility is contained.

4. CODES, STANDARDS, AND GUIDES.

In addition to applicable codes, standards, and guides identified in the basic design Chapter I through XV of this Order, the latest editions of those listed below shall also be followed:

a. ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

b. ANSI N13.1, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities."

c. ANSI N13.3, "Dosimetry for Criticality Accidents."

d. ANSI/ANS 8.3, "Criticality Accident Alarm System."

e. ANSI N101.6, "Concrete Radiation Shields."

f. ANSI N512, "Protective Coatings (Paints) for the Nuclear Industry."

g. ANS 2.1, "Guidelines for Seismic and Geologic Investigations to Determine the Operating Basis Earthquake and Associated Vibratory Ground Motion."

h. 10 CFR 100, "Reactor Site Criteria."

i. ANSI N510, "Testing of Nuclear Air Cleaning Systems."

j. ANSI N42.18, "Specification and Performance of On-Site Instrumentation of Continuously Monitoring Radioactivity in Effluents."

k. ANSI N317, "Performance Criteria for Instrumentation Used for In-Plant Plutonium Monitoring."

5. DOE DIRECTIVES.

Other DOE Orders to be followed include the latest editions and changes to those listed below and Attachment I-1 Chapter I of this Order:

a. DOE 5480.1A, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS, of 8-13-81.

(1) Chapter I, "Environmental Protection, Safety, and Health Protection Standards," of 8-13-81.

(2) Chapter III, "Safety Standards for the Packaging of Fissile and Other Radioactive Materials," of 5-1-81.

(3) Chapter V, "Safety of Nuclear Facilities," of 8-13-81.

(4) Chapter VII, "Fire Protection," of 12-18-80.

(5) Chapter XI, "Requirements for Radiation Protection," of 4-29-81.

(6) Chapter XII, "Prevention, Control, and Abatement of Environmental Pollution," of 12-18-80.

b. DOE 5481.1A, SAFETY ANALYSIS AND REVIEW SYSTEM, of 8-13-81.

c. DOE 5630.1, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, of 8-3-79.

d. DOE 5630.2, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, BASIC PRINCIPLES, of 8-21-80.

e. DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER, of 7-18-79.

f. DOE 5632.2, PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS, of 2-16-79.

g. DOE 5700.6A, QUALITY ASSURANCE, of 8-13-81.

h. DOE 4300.1A, REAL ESTATE (Real Property) MANAGEMENT, of 7-7-83.

i. DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING, of 3-17-83.

6. SITE EVALUATION AND STUDIES.

Site evaluation and studies necessary to provide the technical basis for location, design, and operation (under normal operations and DBA conditions) of the facility shall include but not be limited to the items shown below. In addition, appropriate consideration shall be given to long-term as well as immediate consequences of releases, including ground decontamination. Also see DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING, and DOE 4300.1A, REAL ESTATE MANAGEMENT for new site selection requirements and procedures.

a. Location.

(1) In the siting and design of facilities, the radiological siting requirements in paragraph 3i(5), page I-14, Chapter I of this Order shall be satisfied.

(2) Other Facilities and Operations.

(a) Proximity to internal plant operations. Specifically, isolation from on-site hazards external to the facility (fire, explosions, radiation, gas mains, large quantities of explosives, flammable gases, and so forth) shall be evaluated.

(b) Proximity to potentially hazardous external plant operations, such as airports and private industry, shall be evaluated.

(3) Services. Proximity to utilities, fire department, and so forth shall be evaluated.

b. Meteorology. All available meteorological data shall be evaluated. At a minimum, at least one year of valid meteorological data shall be used to properly develop estimated joint frequency distribution of windspeed and stability conditions. These data shall be used to estimate dispersal of effluents under normal and accident conditions.

c. Hydrology. Site studies shall be performed to determine ground water levels, precipitation, flooding runoff, drainage, and so forth.

7. PLANT FEATURES.

a. Facility Design.

(1) General.

(a) Critical items and systems (ventilation, electrical, fire protection, and utility systems) shall be designed to provide confinement of radioactive materials under normal operations and DBA conditions. The degree of confinement of radioactive materials shall be sufficient to limit releases to the environment to the lowest reasonably achievable level. In no case shall the applicable exposure regulations be exceeded, either with respect to the operating personnel, or to the public at the boundary or nearest point of public access. Consideration shall be given to the probability and effects of DBAs. Protection of employees within the facility shall be a consideration in all aspects of the design. The nature of the material to be handled, including the isotopes of plutonium and/or other radioactive elements present, shall be taken into account in making these assessments.

(b) Structural design, including loading combinations and construction of critical items, shall, as a minimum, be in accordance with current editions of pertinent nationally recognized codes and standards as identified in Chapter IV, and Chapter X of this Order and the criteria contained in this Chapter.

(c) All other facility design shall conform to applicable criteria in other portions of this Order (Chapters I through XV) and to other site- or process-specific criteria developed for the facility.

(2) Tornado, and Other Wind and Storm Design Requirements.

(a) Use shall be made of the site-specific tornado hazard curves, available from the Headquarter's Office of Nuclear Safety, in selecting the appropriate tornado windspeed magnitude to be applied. Design of critical items for tornado resistance shall be based on the characteristics of a tornado with a recurrence time of 1,000,000 ($10^6$) years. If such curves are unavailable or deemed inappropriate then the geographical intensity regions shown in Attachment XXI-1, and the associated design basis tornado characteristics shown in Attachment XXI-2 shall be used in designing for tornado resistance; unless it can be demonstrated by a detailed evaluation on a case-by-case basis that lesser values pertain to a given site. Headquarters approval shall be obtained to design for these lesser values. Procedures for requesting Headquarters approval are contained in Chapter I of this Order. The geographical intensity regions shown in Attachment XXI-1 and the associated design basis tornado

characteristics shown in Attachment XXI-2 are the same as those contained in U.S. Nuclear Regulatory Commission Regulatory Guide 1.76, "Design Basis Tornado for Nuclear Power Plants," of April 1974; and are both based on the study entitled, "Technical Basis for Interim Regional Tornado Criteria," WASH-1300.

(b) In designing for tornado resistance:

1 The rotational speed shall be appropriately combined with the translational speed.

2 Resulting loads from the rate of pressure drop, taking into consideration any pressure equalization due to permissible venting, shall be combined with velocity-induced pressure loads in a rational manner.

3 Characteristics of potential tornado-generated missiles (see Attachment XXI-3) shall be conservatively determined from review of onsite sources and possible missiles that could be borne to the site by a tornado. Small high-velocity missiles and massive low-velocity missiles shall both be considered separately in terms of penetration, perforation, or crushing effects.

4 Critical items capable of being subjected to tornado forces shall be designed for the loads induced by such forces, including missile loads, in combination with applicable functional design loads.

a Load Combinations for Concrete Structures. The strength design method should be used for the design of reinforced concrete structures with the ultimate strength (U) of any structural component not less than that given by the following basic equations:

$$U = 1.1(D + L) + 1.0\ W_t$$

$$U = 0.9\ D + 1.0\ W_t$$

Where D = Dead Load
L = Live Load
Wt = the appropriate design tornado generated loads or combination of loads, selectively applied in each of the above equations, which will result in the most severe loading condition (tension, compression, shear, or torsion) for the component under consideration. The tornado generated loads include wind forces, pressure differentials and missiles.

The first load combination given shall include both full value and zero value of L to determine the more severe condition. The reduced value of dead load D in the second combination is included for the case where a higher dead load reduces the effects of other loads.

b Load Combination for Steel Structures. Either elastic design methods of Part 1 or plastic design methods of Part 2 of AISC, "Specification for Design, Fabrication, and Erection of Structural Steel for Buildings", may be used for the design of steel structures subjected to tornadic forces, including missile loads, in combination with applicable functional design loads. The strength (U) of any structural component shall not be less than that given by the following basic equations:

Elastic Design Methods

$$U = 1.1\ (D + L) + 1.0\ W_t$$
$$U = 0.9\ D + 1.0\ W_t$$

Allowable stress levels for use with the above load combinations shall not exceed 90 percent of yield when elastic design methods are used, and 100 percent of yield when plastic design methods are used.

5 The design basis tornado shall be assumed capable of occurring at any time except that the simultaneous occurrence with any other limiting site-related event such as an earthquake, or fire, or flood need not be considered for design purposes except where the joint occurrence is causally related (e.g., fire from lightning or other causes).

6 To provide assurance that the design basis tornado will govern at the particular site, comparison against extreme wind (highest speed of wind with a recurrence time of $10^4$ years) should be made. See paragraph 9b(2)(b)5 in Chapter IV of this Order.

(c) Protection against infrequent severe natural phenomena does not have to be provided for an area where no critical safety functions are involved or no significant radiological hazard potential exists. Where requirements of safety or continued operations and equipment survival costs are not overriding, reduced requirements may be employed, based upon a thorough review and documentation of historic wind, hurricane, and tornado data observed and experienced at the site. The minimum wind velocity used in this case shall be that associated with the one-hundred year mean recurrence interval of extreme winds, as specified in ANSI Standard A58.1.

(3) Seismic Design Requirements. Seismic parameters shall be developed for the site to determine a DBE and an OBE. The Safe Shutdown Earthquake (SSE) is also identified in these criteria as the DBE. The smaller earthquake, the OBE, shall be no less than 0.05g in terms of ground acceleration. Critical items shall be designed to withstand the DBE and shall be capable of continued operation after the occurrence of an OBE. Continuation of operation for a safe shutdown condition requires that capability be retained in critical items to safely respond to DBAs in critical areas which are postulated for the shutdown condition. Critical areas shall be capable of retaining full operability under an OBE. Evaluation shall be made on a case-by-case basis of other than critical items to determine if operability should be retained for a DBE or OBE. If operability under or following a DBE or OBE is not required for other facilities, the Uniform Building Code (UBC) should be used to determine the seismic design resistance.

(a) Determination of Size of Earthquake. Procedures similar to those stated in "Seismic and Geologic Siting Criteria for Nuclear Power Plants", Appendix A to 10 CFR 100, shall be used for determining the quantitative design basis for vibratory ground motion at the site due to a DBE or OBE. For either case, the design basis earthquake shall be defined by design response spectra, appropriate for the site, or by acceleration-time histories, representative of anticipated ground motions.

(b) Earthquake Analysis. The adequacy of critical items shall be verified using a suitable dynamic analysis technique, such as the response spectrum method, except where it can be demonstrated that the use of a simplified approach, such as a static load method, component testing, or others, provides adequate conservatism. This simplified approach may include analyses of representative examples of a given type of system, and demonstration that such analyses conservatively describe the behavior of systems. It may also be necessary to perform dynamic analyses of representative examples to adequately describe the behavior of systems. The ratio of vertical to horizontal acceleration shall be two-thirds unless specific site considerations justify use of a different ratio.

(c) Earthquake Occurrence. The DBE and OBE shall be assumed capable of occurring at any time, except that the simultaneous occurrence with any other limiting site-related event such as a tornado, or fire, or flood need not be considered for design purposes, except where the joint occurrence is causally related (e.g., fire or flood).

(d) Load Combinations and Stress Limits. All critical items shall be designed to enable a safe shutdown and continuation of functions in a safe shutdown condition, and to conform to the following:

1 For service load conditions, including normal design loads and the OBE loads, either the working stress design method or the strength design method shall be used for reinforced concrete structures. Elastic design methods of Part 1 of AISC, "Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings," or plastic design methods of Part 2, may be used for the design of steel structures. The load combinations and stress allowables used, for the design of service load conditions, shall be those set forth in the codes referenced herein, including the appropriate stress increases or load factors for loading combinations with earthquake forces.

2 For extreme load conditions, including normal operating loads and the DBE, the strength design method for reinforced concrete structures and either elastic or plastic design methods for steel structures may be used in conjunction with the following basic load combinations and allowable stresses:

a Load Combinations for Concrete Structures. The strength design method should be used for the design of reinforced concrete structures with the ultimate strength (U) of any structural component not less than that given by the following basic equations:

$$U = 1.1\ (D + L) + 1.0\ DBE$$
$$U = 0.9\ D + 1.0\ DBE$$

Where D = Dead Load
L = Live Load
DBE = the appropriate DBE loads, selectively applied in each of the above equations, which will result in the most severe loading condition (tension, compression, shear, or torsion) for the component under consideration.

The first load combination given shall include both full value and zero value of L to determine the more severe condition. The reduced value of deal load D in the second combination is included for the case where a higher dead load reduces the effects of other loads.

b Load Combinations for Steel Structures. Either elastic design methods of Part 1 of AISC, or plastic design methods of Part 2 of AISC, may be used for the design of steel structures. The strength of any structural component shall not be less than that given by the following basic equations:

Elastic Design Methods

$U = 1.1 (D + L) + 1.0\ DBE$
$U = 0.9\ D + 1.0\ DBE$

Plastic Design Methods

$U = 1.4 (D + L) + 1.2\ DBE$
$U = 1.1\ D + 1.2\ DBE$

Allowable stress levels for use with the above load combinations shall not exceed 90 percent of yield when elastic design methods are used, and 100 percent of yield when plastic design methods are used.

3 Design for load combinations including normal operating loads, DBE loads, and applicable DBA loads shall be done so that there is no loss of function of the specific structure, system, or component.

(4) Other Natural Phenomena. Design loads and considerations for other natural phenomena shall provide a conservative margin of safety greater than the maximum historical levels recorded for the site. Protection against flooding shall be based on no less than the probable maximum flood (PMF) for the area as defined by the Corps of Engineers. The possibility of seismically-induced damage or failure of upstream dams shall be taken into account in assessing the nature of flood protection required for the facility.

(5) Fire Resistance. Development of the DBF shall include consideration of conditions which may exist during normal operations and special situations, such as during periods of decontamination, renovation, modification, repair, and maintenance. The structural shell surrounding critical areas and operating area compartments and their supporting members shall be designed with sufficient fire resistance so that it will remain standing and continue to act as a confinement structure during the DBF postulated for the facility assuming failure of any fire suppression system which is not designed as a critical item. Fire resistance of this shell shall be attained as an integral part of the structure (concrete walls, beams, and columns) and not by a composite assembly (membrane fireproofing). In no event shall the fire resistance rating be less than two hours. Penetrations in this shell shall incorporate, as a minimum, protection against DBF exposures unless greater protection is required by other subparts of these criteria. The systems identified as critical items for critical areas shall be designed to continue to operate during the DBF. A high degree of reliability and/or redundance shall be required of all protective features of the ventilation system to assure its effective operation even if normal plant utility and fire protection systems fail.

(6) Explosion, Internal Pressurization, Criticality, and Other DBA Causes. Analysis shall be made to determine the probable consequences of DBAs, and critical areas and critical items shall be designed to withstand these DBAs. That portion of the ventilation system which is an integral part of the critical areas shall be designed to withstand the DBAs so that it will remain intact and continue to act as a confinement system.

b. Layout of Plutonium Handling Areas. The design layout of the plutonium facilities shall consider the following:

(1) Operations. All planned processing, research and development, scrap and waste handling, analytical, shipping, and receiving operations shall be accommodated. Provisions shall be made to minimize the buildup of scrap. Receiving operations involving removal of radioactive material from protective shipping containers shall be performed in a handling area having provision for confinement. The possibility of multishift-per-day operations shall be taken into account in allocating space for personnel support facilities and for any special equipment which might be required to support multiple shift operations.

(2) Confinement. Where practicable and/or necessary by reason of the nature of the processes being conducted, recycle ventilation systems should be used in process enclosures, hot cells, and/or canyons. Inert gas systems shall, unless impracticable to do so, be designed as recycle systems. Cooling, drying, and minimum makeup capability should be provided as appropriate.

(3) Versatility. Facility design should provide, to the maximum extent practicable, sufficient versatility to accommodate equipment for programmatic changes and process modifications.

(4) Compartmentalization. Compartmentalization shall be provided to isolate high risk areas to minimize productivity loss and financial loss in case of a DBA.

(5) Modular Construction. Where feasible, the above items should be adapted into a modular construction concept to expedite recovery from DBAs and provide versatility.

(6) Spacing. Sufficient spacing between units and in passageways should be incorporated into the design to facilitate relocation and maintenance of equipment, ease of operation, and reduce radiation exposures due to adjacent operations.

(7) Exists. Personnel exists shall be provided in accordance with the NFPA Life Safety Code. In those areas where an accidental breach of a primary confinement system will expose personnel to radioactive material, a distance of approximately 75 feet shall be considered the maximum level distance to place personnel beyond or through the next confinement barrier. Such a barrier would be a partition separating

two different air zones, the area of refuge being on the upstream side of the barrier. The assured airflow through the barrier should be in the opposite direction of the exist travel.

c. Fire Protection. Plutonium facilities shall be designed to prevent, suppress, and contain fires and products of combustion. The desirability or need for automatic suppression and/or detection systems shall be evaluated for all areas of the facilities, and the design of the structures and fire suppression systems shall meet, as a minimum, the requirements of Chapter X of this Order and Chapters I, VII, XI of DOE 5480.1A. At a minimum, fire protection requirements shall include automatic sprinkler or equivalent coverage throughout the facility, with the provision of special hazard fire control measures where particular hazards exist. Adequacy of any proposed "equivalent coverage" shall be verified by the fire protection engineering staff of the responsible DOE field office.

d. Nuclear Criticality. Design of nuclear criticality control provisions, including equipment and procedures, shall meet, as a minimum, the requirements of Chapter V (Safety of Nuclear Facilities) of DOE 5480.1A. Design shall further assure that fissile material shall not be displaced to form a critical mass in the event of an internal or external accident. Wherever possible, poisoned or geometrically favorable tanks and process vessels shall be provided to minimize reliance on administrative control. A system of backflow prevention, such as air gaps, shall be provided to prevent the inadvertent transfer of liquids from geometrically favorable or poisoned containers to unsafe containers. Positive control to prevent the discharge of liquids from geometrically favorable or poisoned containers to unsafe containers shall be provided.

e. Ventilation.

(1) General.

(a) Ventilation systems shall be designed to confine radioactive materials under normal and DBA conditions and to limit radioactive discharges to the practicable minimum. Where the process requirements or other considerations dictate, inert atmospheres will be used in enclosures. In such cases, the use of recycle ventilations shall be considered, taking into account both safety and economic factors. Suitable means of by-passing the recycle system should be considered, in the event it is desirable to discharge the ventilation flow directly to the exhaust system. In general, recirculating air systems should be considered only for use in non-radioactive or non-toxic environments. Exceptions should be considered only after a careful evaluation of comparative safety risks.

(b) Design of ventilation systems shall assure that air flows are, under all normal conditions, toward areas of progressively higher radioactive contamination. Air handling equipment shall be sized sufficiently conservatively that minor upsets in air

flow balance (e.g., improper use of an air lock, occurrence of a credible breach in a confinement barrier) do not result in flow reversals. HEPA filters shall be provided at ventilation inlets in confinement areas barriers to prevent movement of contamination from areas of higher levels of areas of lower levels in the event of a flow reversal. Ventilation system balancing shall assure that the building air pressure is always negative with respect to the outside atmosphere.

(c) Safety analysis shall establish the minimum acceptable response requirements for the ventilation system, its components, and instruments and controls under normal, abnormal, and accident conditions. Minimum acceptable system response requirements may range from none, remaining intact but not necessarily operable, being operable in a derated fashion, to operating at full capacity before, during, and after a DBA. These requirements shall determine system and component design characteristics such as installation of standby spare units, provision of emergency power for fans, installation of tornado dampers, seismic qualification of filter units, fail-safe valve positioners, and so forth.

(d) The number of required exhaust filtration stages from any area of the facility shall be determined by analysis to limit quantities and concentrations of airborne radioactive or toxic material released to the environment during normal and accident conditions, in conformance with applicable standards, policies, and guidelines. Roughing filters and/or enclosure prefilters are not considered to be a radioactive particulate filtration stage, but their use shall be considered to avoid needless dust loading and plugging of high efficiency particulate air (HEPA) filters. See Chapter V of this Order for air cleaning systems criteria.

(e) The principle of compartmentalization shall be employed to limit the extent of contamination and minimize loss of productivity and property in the event of a DBA.

(f) Use of downdraft ventilation within enclosures shall be considered as a means of reducing fire and contamination spread potential.

(2) Ventilation Requirements.

(a) Room supply air shall be appropriately conditioned commensurate with operational requirements.

(b) A partial recirculating ventilation system shall be considered for economic and safety reasons. However, such systems shall be designed to preclude the entry of enclosure exhaust into room air recirculating systems.

(c) Critical items of the ventilation system and the related fire suppression and detection system shall be supplied with emergency power. Controls for these systems shall be supplied with uninterrupted emergency power.

(d) Sufficient redundancy and/or spare capacity shall be provided to assure adequate ventilation during normal operations and DBA conditions.

(e) Failure of any single component or control function shall not compromise minimum adequate ventilation.

(f) The exhaust system shall be designed to provide cleanup of radioactivity and noxious chemicals from the discharge air and to safely handle products of combustion as required by paragraph (g) below.

(g) Design of the system shall include an analysis to assure that the ventilation system is capable of operating under DBF conditions. It should be designed to assure, to the maximum extent practicable, that products of combustion are not spread beyond the room of origin unless safely directed through appropriate ventilation channels.

(h) Provisions may be made for independent shutdown of ventilation systems where this could possibly be an advantage to operations, maintenance, or emergency procedures such as firefighting. In assessing the desirability of providing for shutdown of a ventilation system under such conditions, full consideration shall be given to all possible effects of the shutdown on air flows in other, interfacing ventilation systems. Positive means of controlling backflow of air which might transport contamination shall be provided.

(i) A HEPA filter shall be installed at the interface between the enclosure and the ventilation system to minimize the contamination of ductwork. A roughing filter should be installed to reduce high efficiency filter loading. Unless such filters can be reliably tested in place, they shall not be considered to be the first stage of the airborne contamination cleaning system.

(j) The available quality assurance services identified in Chapter V of this Order shall be utilized for independent inspection and testing of HEPA filters used in plutonium facilities.

(k) The filtration systems shall be designed to allow reliable in-place testing of the high efficiency filters and ease of filter replacement to the maximum extent practicable.

(3) Ventilation Systems.

(a) Airborne contamination cleaning systems may include any or all of the following elements. In the design of the overall filtration/treating system, appropriate consideration shall be given to each of these, and to their potential interactions under both normal and credible adnormal conditions.

1 Prefilters.

2 Scrubbers.

3 Process vessel vent systems.

4 HEPA filters.

5 Sand filters.

6 Glass fiber filters.

7 Demisters.

8 Condensers.

9 Distribution baffles.

10 Fire suppression systems.

11 Heat removal systems.

12 Pressure and flow measurement devices.

13 Drain system including tanks to prevent the formation of an unsafe geometry when water is used in fire suppression activities.

(b) Supply air shall be appropriately filtered. If room air is recirculated at least one stage of HEPA filtration shall be provided in the recirculation circuit.

(c) The ventilation system and associated fire suppression system shall be designed for fail-safe operations.

(d) The ventilation system shall be appropriately instrumented and alarmed, with readouts in control areas located in the utilities services area for the facility, to report and record its behavior.

(e) Consideration shall be given to both automatic and manual controls to alter system operation during unusual conditions.

(2) Hand and Forearm Protection. Remote shielded operation shall be utilized (i.e., with remote handling equipment such as remote manipulators) where it is anticipated that exposures to hands and forearms would otherwise approach 15 rems per year, or where contaminated puncture wounds could frequently occur.

(3) Air Monitoring and Warning Systems. Air monitoring and warning systems shall be installed in work areas where radioactive material is handled. Air sampling heads (a part of a central air sampling system) shall be appropriately located to provide a representative sample of the potential airborne radioactivity being breathed. Air monitoring systems should be in accordance with ANSI Standard N.13.1, "Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities."

(4) Personnel Monitoring and Warning Devices. Provisions shall be made for personnel monitoring devices, such as hand counter, in the vicinity of work stations. Continuous air monitoring systems (CAMS) shall be provided to detect and to alarm airborne contamination levels. Devices shall be considered to warn personnel of possible contamination hazards.

(5) Ionizing Radiation Monitoring System. An area radiation monitoring and alarm system shall be provided to alert plant personnel of unexpected increases in radiation levels. (Appropriate design of item (6), below, could prempt this requirement).

(6) Criticality Alarm System. A criticality alarm system (gamma or neutron) shall be provided to meet, as a minimum, the requirements of Chapter V (Safety of Nuclear Facilities) of DOE 5480.1A. This system should be provided with emergency power.

(7) Warning and Alarm System Features. Warning and alarm systems shall be designed, installed, and tested to assure that they can be heard in the ambient conditions of the area they are intended to cover.

(8) Nuclear Accident Dosimetry. Nuclear accident dosimeters shall be provided with performance features and placement consistent with the requirements of Chapter XI (Requirements for Radiation Protection) of DOE 5480.1A.

(9) Provisions for Decontamination of Personnel. Design shall provide for decontamination of personnel in all areas reasonably close to sources of potential contamination. Plans shall be developed and provisions made for the management of highly contaminated emergency cases.

(10) Central Radiation Monitoring and Alarm Readout. In addition to a local station alarm, the radiation monitoring systems (criticality alarms, CAMS, alarms associated with stack monitoring systems, and so on) should incorporate the features of central readout and alarm panels.

(11) Meteorological Equipment. Meteorological equipment shall be provided to measure and record wind speed and direction.

g. Other Special Safety Features.

(1) Special Testing. The design should provide the capability to test periodically, under simulated emergency conditions, system components and devices which are required to function under emergency conditions.

(2) Space. In order to accommodate possible future programmatic changes, changes in radiation protection requirements, or other contingencies, the design of the facility shall consider provision of space for the following purposes:

(a) Shielding for personnel and/or remote operation of equipment and processes.

(b) Addition of inert atmosphere enclosure systems including their regeneration trains to accommodate process requirements and fire safety.

(c) Mechanical equipment and utility capability to accommodate the above.

h. Contamination Confinement. In general, the primary contamination confinement shall be the process enclosures and their ventilation system. In special cases where the processes require the use of corrosive or noxious materials, the process system may be totally enclosed and provided with its own vent system and off gas cleanup system. In such cases, the process system will be treated as the primary confinement system. Secondary confinement shall be the operating area compartments and their ventilation system, and the final confinement shall be the structure and its ventilation system. Design objectives for the confinement system shall be an essentially zero exposure of the public and plant personnel to airborne contamination.

(1) Primary Confinement System.

(a) Integrity. The design of process enclosures of process systems, as appropriate, shall provide confinement during normal operations.

(b) Modular Construction. When glove boxes are used, their design and construction should be such as to permit replacement or relocation of the box within the system with a minimum spread of contamination.

(c) Conveyors. If needed, conveyors should be used to interconnect enclosures and/or glove box systems to minimize introduction and removal of materials from the system.

(d) Introduction and Removal Stations. Special design features shall be considered to assure safe introduction and removal of materials from process enclosures.

(e) Piping and Tankage. Protective housings shall be considered for pipes and tanks used for plutonium transfer and storage. These pipes and tanks shall be sized to be geometrically safe for the plutonium concentration to be used or shall contain a fixed neutron poison, such as borosilicate glass "raschig rings." Care should be taken in locating valves and flanges to minimize the consequences of contamination from leaks. If the "raschig rings" are employed, tanks shall be provided convenient means for periodically checking to verify the presence and level of the rings in the tanks.

(2) Operating Area Compartments and Critical Structure

(a) Integrity. The design of the operating area compartments and the critical structure shall provide confinement during normal operations and DBA conditions.

(b) Penetrations. All penetrations of the operating area compartments shall have positive seals to prevent the migration of contamination out of the confinement area.

(c) Ventilation. Each compartment shall be supplied ventilation air from the building ventilation system, and shall be provided separate exhaust ventilation handled by a system with sufficient capacity to ensure an adequate ventilation flow in the event of a credible breach in the compartment confinement barrier. Pressure in the compartments shall be negative with respect to the building ventilation system and slightly positive with respect to the process enclosures.

(3) Change Rooms. Change rooms should be provided for changing into and from protective clothing. These areas should be adjacent to shower facilities. A filtered-air exhaust system shall be considered for the change room.

i. Airlocks. Movement between plutonium handling areas and other areas shall be through airlocks. Provision for normal and emergency equipment should be provided for, in or adjacent to the airlocks. Consideration shall be given to emergency lighting, paging systems, automatic access door switches, hand and foot monitors, storage for clothing and emergency equipment, warning lights, air sampling, and breathing and air outlets.

j. Decontamination. Design of the critical areas shall incorporate measures to simplify decontamination. Such items as service piping, conduits, and ductwork should be kept at minimum in the operating areas and be arranged to facilitate decontamination. Walls, ceilings, and floors should be finished with washable or strippable coverings or covered with metal liners if required. Where paints are to be used, they shall comply with the specifications as contained in ANSI Standard N512, "Protective Coatings (Paints) for the Nuclear Industry." All cracks, crevices, and joints shall be caulked and finished smooth to prevent contamination of inaccessible areas.

k. Decommissioning. Decommissioning of the plutonium facility is of utmost importance and design shall be such that at some future date the facility can be decontamined for future decommissioning. The design principles which shall be considered are:

(1) Use of modular, separable enclosures for use of radioactive materials to preclude contamination of fixed portions of the structure.

(2) Use of glove box enclosure design which takes into account any restrictions imposed by limitations on the dimensions of packing crates for disposal, (e.g., current DOE criteria limit the size of packing crates which will be accepted at the TRU repository to 4' x 4' x 7').

(3) Use of localized liquid transfer systems that avoid long runs of buried contaminated piping; emphasis on localized batch solidification of liquid waste. Special provisions should be included in the design to assure the integrity of joints in buried pipelines.

(4) Location of exhaust filtration components of the ventilation systems so as to minimize long runs of internally contaminated duct work.

(5) Effluent decontamination equipment that precludes, to the extent practicable, the accumulation of radioactivity in relatively inaccessible natural soil columns, such as beneath "see page basins."

l. Maintenance.

(1) Critical items shall be designed to permit inspection, maintenance, and testing to assure their continued functioning. Ancillary equipment, such as pumps, blowers, motors, compressors, drive motors, gear trains, and controls should be located in an area least likely to be contaminated. All equipment which must be located within enclosure systems should be designed to allow for in-place maintenance and/or replacement.

(2) An area should also be provided for the maintenance of contaminated equipment which cannot be repaired in place. In respect to ventilation, confinement provisions, and liquid and solid waste control, this area should have all the features of the operating area or laboratory.

m. Water Collection System. Collection systems should be provided for water runoff from the plutonium handling area, such as from firefighting activities. Nuclear criticality, confinement, sampling, volume determination, and retrievability of liquids and solids shall be considered in the design of collection systems. The size of the collection system for firefighting water should be based on the maximum amount of water which would be collected in fighting the DBF and the configuration of the components of the system should be based on conservation assumptions as to the concentration of fissionable material which might collect in the system. Recirculating systems shall also be considered when there is no possibility of contamination.

8. UTILITIES.

a. General. The design of utility services shall provide reliability consistent with operational requirements, value of in-process product, and potential hazard for all probable conditions. Utility systems essential to the support of critical areas of the plutonium facility shall be designed to the same integrity as the critical areas of the facility which they serve.

b. Fire Protection. The design of the water supply system shall provide water for firefighting and automatic sprinkler systems in accordance with the criteria in Chapter X of this Order, and FM, IRI, and NFPA Standards. Fire protection water supply and distribution design required for critical item protection shall assure continuity of protection in the event of a DBA.

c. Water. Isolation of the facility water system from primary water mains should be preferably by air gap (if air gap is not possible, reduced pressure type of backflow preventers shall be used) to prevent any possibility of contamination of public water supplies. The potable water system shall be protected from contamination.

d. Flammable Gas. Significant quantities of flammable gas shall be restricted to use in a central service building or equipment buildings. Gas piped to a plutonium processing building shall not enter the building at a pressure exceeding 6" water. Construction shall be designed to prevent gas from leaking into a plutonium processing facility from gaslines or pressure reducers at a higher pressure than this outside the building.

e. Supply Air. Continuous monitoring of oxygen levels shall be considered for occupied working areas of facilities equipped with significant quantities of inerted or oxygen deficient process glove box lines.

f. Electric Utilities.

(1) Preferred Primary Feeder. This source is the basic service to the facility and should consist of a radial feeder connected directly to the main substation serving the area. In order to minimize power outages, this feeder should be an express feeder and should not have any other loads connected.

(2) Alternate Primary Feeder. This source of power is for the same overall purpose as that of preferred primary feeder and shall be in ready standby for use by automatic transfer in the event of a forced outage or planned maintenance of the preferred primary feeder. This feeder should also be a radial feeder connected directly to a substation that is electrically independent of the substation serving the preferred primary feeder and should not have any other loads connected to it. In order to minimize simultaneous outages of the preferred and alternate primary feeders due to lightning or other physical damage, the two feeders shall have maximum physical separation.

(3) Emergency Power. The emergency power source shall be completely independent of both the preferred and alternate primary feeders. This power source shall start automatically in the event both preferred and alternate sources fail. The emergency power source shall have adequate capacity to carry those loads which are necessary to maintain the integrity of the facility and provide for personnel safety.

9. WASTE MANAGEMENT.

a. Wastes from plutonium handling facilities include both radioactive and non-radioactive species, and will be in the form of liquid or gaseous effluents, or solids packaged for shipment off-site. A principal design objective for the process systems shall be to minimize the production of wastes at the sources. A principal design objective for the waste management systems shall be to provide facilities and equipment to handle those wastes safely and effectively. Volume reduction equipment for both liquid and solid wastes should be provided and should be designed for process capability and capacity commensurate with the expected types and quantities of wastes expected. Waste handling areas shall be subject to the same standards of confinement and ventilation requirements as other processing areas.

b. Effluents (both radioactive and non-radioactive) from the plutonium handling facility include air and other gaseous exhausts and liquid wastes. The contamination in the effluents shall be as low as reasonably achievable, commensurate with latest accepted technology at the time of design. Emphasis shall be placed on reducing total quantities of effluents (both radioactive and nonradioactive) released to the environment. In any event, the effluent concentrations of plutonium shall not exceed the Radioactivity Concentration Guide (RCG), in Chapter XI (Requirements for Radiation Protection) of DOE 5480.1A, for uncontrolled areas measured at the point of discharge (e.g., exhaust ducts and stacks) during normal operations. Consideration shall be given to recirculation systems for process ventilation where feasible. Provisions shall be made for retention systems for liquid effluents. All effluents streams shall be sampled or monitored as appropriate to assure accurate measurements of all releases under normal and DBA conditions.

10. EFFLUENT AND WASTE CONTROL AND MONITORING.

a. Air and Gaseous Effluents Containing Radioactivity. Design shall provide that all air and other gaseous effluents are exhausted through a ventilation system designed to remove particulates. All exhaust ducts (or stacks) which may contain plutonium contaminants shall be provided with two monitoring systems. One should be of the continuous type (Continuous Air Monitoring System (CAMS)) and the other a fixed sampler. These systems may be a combination unit. The probes for sampling purposes should be designed for isokinetic sampling and located according to good industrial hygiene practices. Each monitoring system shall be connected to an emergency power supply.

b. Liquid Waste Containing Radioactivity.

(1) Industrial Wastes. Industrial wastes such as discharge from mop sinks, overflow from positive-pressure chilled circulating waste systems, and process steam condensate (if existing) shall be collected and transferred to a liquid waste treatment plant or similar type treatment area. Provisions shall be made for continuous monitoring and recording of radioactivity, flow volume, and pH. The radioactivity monitor shall have an alarm located in the liquid waste treatment plant or area. Consideration shall be given to retention systems.

(2) Process Wastes. Liquid process wastes shall be collected and monitored near the source of generation before batch-wise discharge through appropriate piplelines or by tank transfer to a liquid waste treatment plant or area. These wastes should be individually collected at that facility in storage tanks which are equipped with stirrers, sampling and volume measuring devices, and transfer systems. Process waste storage tanks and transfer lines should be designed and constructed so that they are fully inspectable, and that any leakage will be detected and contained before escape to the environment occurs. Transfer lines should have inspection/collection pits at practical intervals into which leakage can drain by gravity. The use of double-walled transfer pipelines should be encouraged. Nuclear criticality safety shall be considered in the design of collection and monitoring systems for liquid process wastes.

c. Solid Waste Containing Radioactivity. Design shall include adequate provisions for the safe collection, packaging, storage, and loading for transport of solid waste containing radioactivity which will result from facility operations. These provisions shall include allocation of adequate space for sorting and safe temporary storage of solid waste, equipment for assay of the waste, facilities for volume reduction appropriate to the types and quantities of solid waste expected to be produced, and suitable processes and equipment for recycle of those solid wastes which would be economical to reprocess. All packages containing solid radioactive waste shall be appropriately monitored, both before being moved to temporary storage locations and before being loaded for transport to a disposal site.

d. Nonradioactive Effluents. Liquid and airborne effluents shall comply with applicable Federal, state and local air and water pollution control standards in accordance with Chapter XI and Chapter XII of this Order, and Chapter XII (Prevention, Control, and Abatement of Environmental Pollution) of DOE 5480.1A.

e. Sanitary Wastes. Federal, state, and local codes regarding discharge of sanitary wastes shall be met. There shall be no interconnection between the sanitary waste system and the plutonium handling area. The sanitary waste shall be monitored for radioactivity.

f. Miscellaneous. Consideration should be given to the collection and monitoring of natural runoff (e.g., roof drainage) and blowdowns from heating and cooling systems before discharge to environs.

11. ENCLOSURES. Enclosures and their ventilation systems are the primary confinement systems and, therefore, their integrity shall be of primary design importance. Where feasible, all equipment components not functionally required to operate directly in the presence of plutonium should be located outside the enclosure.

a. Construction. Noncombustibles or fire resistive and corrosion resistant materials shall be used for enclosures and, to the maximum extent practicable, for any required radiation shielding. Design of the enclosures should include standarized features such as windows and mountings; glove ports (size, location, and height); ease of cleaning (radius corners, smooth interior and exterior surfaces, minimal proturberances, and acessibility of all parts); adequate interior illumination (from fixtures mounted on the exterior where feasible); connections for service lines. conduits, instruments leads and ductwork; firestop and filter installations; sample removal ports; pressure differential readouts; lead rate indicators; and attachments for interconnection of enclosures. Where pertinent, the enclosure design shall take into account the heat release from radioactive material in the enclosure. This is particularly applicable to storage enclosures. Consideration shall be given for modular construction, versatility, relocation, and incorporation of shielding if necessary. Discrete work stations within enclosures should be separated from each other by fire stops to prevent the spread of fire. Generally the fire stops within and between enclosures should be such that they are normally closed. Where operations require that the fire stops be in the open position, they shall be designed to be closed upon activation of the fire detection system. Manually operated closure shall also be provided. Consideration shall be given to providing geometrically safe criticality drains on enclosures.

b. Fire Protection. Fire protection shall be provided in the enclosure systems to meet DOE improved risk objectives specified in Chapter X of this Order and in Chapter VII (Fire Protection) of DOE 5480.1A. Automatic fire suppression provisions shall be in accordance with the criteria in paragraph 7, page X-7, in Chapter X of this Order. When the maximum possible fire loss is estimated to exceed $1 million, an automatic fire suppression system is mandatory. In order to protect against lost from fire originating within the enclosure system, a highly reliable, fast-acting system may be necessary. Instead of such a system, an oxygen deficient atmosphere may be provided as the normal operating atmosphere within the system. Where automatic systems are not required, fire detection shall be installed. Provisions shall also be made for manual fire suppression where deemed necessary.

c. Ventilation. A ventilations system shall be installed on all enclosure systems to maintain a negative pressure inside the enclosure with respect to the operating area. The design shall take into account the possible necessity to remove moisture, heat , explosive and correosive gases, as

e. The use of nonflammable hydraulic, lubricating, cooling, and so forth fluids in plutonium handling areas.

f. The provision of protective barriers around high pressure or other potentially dangerous systems.

g. Provisions for isolation between incompatible chemicals, materials, and processes.

h. The use of reliable pressure-reducing devices for gas lines in the plutonium handling areas.

i. A means of periodic testing and checkout of all monitoring, surveillance, and alarm systems.

14. EMERGENCY PLANNING.

Emergency planning requirements, including space for storage of emergency equipment, shall be considered early in design to assure that facility features provide for ease of evacuation and other emergency requirements and that facility emergency plans are coordinated with the overall plant-complex emergency plan.

15. QUALITY ASSURANCE.

A quality assurance (QA) program shall be developed and implemented for plutonium facility projects to satisfy the objectives and requirements contained in DOE 5700.6A; and in paragraph 3f, Chapter I of this Order.

16. PLUTONIUM MATERIALS SAFEGUARDS.

Plutonium materials safeguards are aimed at assuring that plutonium is not removed from authorized locations or handling by unauthorized personnel. Although this objective is attained primarily by operating procedures, such procedures can be best implemented in facilities that have been planned and designed with plutonium materials safeguards objectives in mind, with design consideration being given to providing the capability for unobstructed criteria should be interpreted in the light of plutonium materials safeguards objectives and to facilitate accuracy, timeliness, and reliability of measurements and inventories, and reliable and timely detection of unauthorized removal of plutonium.

a. Physical Control.

(1) Systems for Detection of Entry. Design of the facility shall provide that entry into an area where there are strategic (category I) quantities of plutonium as specified in DOE 5632.2., PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS, shall require crossing or breaching of at least two physical barriers. One barrier shall be located at the perimeter of the protected area and one at the perimeter of the material access area. A physical barrier shall consist of either a

wall of a building or a fence. Fences, buildings, alarms, and communication systems shall be in conformance with standards and requirements for physical protection, established by the Office of Safeguards and Security (DP-30); and general design criteria for physical protection (to be issued as new Chapter XIV in this Order). The entire perimeter shall have protective lighting with emergency lighting capability.

(2) Personnel and Vehicle Access and Plutonium Removal Control. Design of the facility shall provide for at least two control points. One should be located at a point adjacent to the barrier surrounding the material access area. These control points should be designed for the purpose of monitoring personnel, package, and vehicle access and exit from areas where plutonium is in use or in storage in conformance with the requirements in DOE 5632.2. Design consideration shall be given to providing dressing rooms, personnel inspection areas, and other facilities associated with detection requirements. Provisions are also required for impeding and detecting removal of plutonium at points other than control points such as doors used for emergency purposes.

(a) Personnel and Material Control Points. Doorways or gates, excluding emergency exists, that are used to control personnel and vehicular access shall be designed to be compatible with the operation of a personnel identification system meeting the requirements of DOE 5631.2, PERSONNEL SECURITY PROGRAM, of 11-13-80, and DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER, of 7-18-79.

(b) Personnel and Vehicle Monitoring. Equipment and devices for monitoring shall be provided at control points to detect the presence of plutonium on people, or in packages and vehicles. Minimum quantity to be detected shall be within the capability of current technology.

(c) Shipping and Receiving Areas. Shipping and receiving areas shall be designed to accommodate vehicles within the physical barrier during loading and unloading operations. Design considerations should be given to such features as physical separation of shipping and receiving operations, or facilities needed for safeguards control during concurrent shipping and receiving operations at the same location.

(d) Control Point Lighting. Control point shall be provided with adequate illumination in conformance with standards and requirements of the Office of Safeguards and Security, and be provided with emergency lighting capability.

(e) Communications. Each control point shall have a voice communications terminal with access to two intraplant communications systems. Provisions should be made to eliminate any build spots in radio communications to and from the building.

b. Accountability of Plutonium.

(1) Material Balance Areas. Design of the facility, where the process permits, shall provide physically separate material balance areas (MBA) so that transfers from one MBA account to another correspond to a physical transfer of plutonium. The boundary of the MBA shall be chosen to coincide with points in the process where determination of plutonium transfers to other MBAs can be made. The measurement capability shall be provided so that the components of the material balance formed across the process will be composed entirely of measured quantities. Common nondestructive assay (NDA) equipment can be used for more that one MBA. The selection of MBAs shall be based on the requirements in DOE 5630.2, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, BASIC PRINCIPLES, of 8-21-80. Where the process permits, the following shall be complied with:

(a) Equipment Layout. The layout of the equipment within the facility shall be designed to permit segregation of material balance areas to the maximum extent possible recognizing the primary importance of process requirements.

(b) Equipment Design. Measurement equipment, appropriate to the process, shall be integrated with process equipment to permit quantitative determinations of plutonium in transfers between MBAs, including receipts, shipments, and materials on inventory.

(c) Data Processing. Provisions for data processing shall be made which are commensurate with information processing requirements of DOE 5630.1.

(2) Inventory Capability of Plutonium in Process. Design of the process and measurement equipment shall provide for minimizing scrap inventory and shall provide a capability for measuring the in process inventory, including scrap, at the end of the accounting period in accordance with the basic requirements in DOE 5630.2. Equipment, such as process equipment, storage containers, tankage, and filters, should be designed and arranged to facilitate access for the determination of plutonium content and provide a means of minimizing holdup in the equipment. Process piping and ductwork should be designed to facilitate detection of plutonium holdup.

(3) Inventory Capability of Plutonium in Storage. Design of the storage area and equipment shall provide a capability for accomplishing a physical inventory. Storage areas in the facility shall be designed with features that facilitate identification and retrieval of items containing plutonium, preferably through an automated system. Consideration should be given to segregating plutonium from other materials in the storage area. See paragraph 12, above, for additional storage facilities design criteria.

17. SAFETY ANALYSIS. A safety analysis shall be performed and documented for each new facility, consistent with the requirements of DOE 5481.1, SAFETY ANALYSIS AND REVIEW SYSTEM; and Chapter V, "Safety of Nonreactor Nuclear Facilities" of DOE 5480.1A.

    a. The safety analysis shall be initiated early in the project planning phase. It is important that the analysis be sufficiently complete and documented, for review and approval, as early as practicable during conceptual design of the facility. It is desirable that design basis accident parameters, other principal design bases, operational and occupational health and safety requirements, and the necessary facility designed and construction features are adequately identified and appropriately factored into the conceptual design prior to establishing the project cost estimate and requesting Congressional authorization for design and construction.

    b. The preliminary safety analysis report Preliminary Safety Analysis Report (PSAR) should be completed during the conceptual design phase, or at least prior to the start of detailed (Title II) design work. The PSAR serves as an important management tool in the design decision-making process.

    c. The safety analysis report (SAR) shall be finalized prior to initial facility operations, and made a part of the permanent project/operating records. It shall be updated as appropriate to reflect changes affecting safety, which are made to the facility during its lifetime.

    d. Typical elements to be addressed in safety analysis, and in the safety analysis reports (PSAR and SAR) are identified in paragraph 3b(2), Chapter I of this Order and in DOE 5481.1A, as referenced therein.

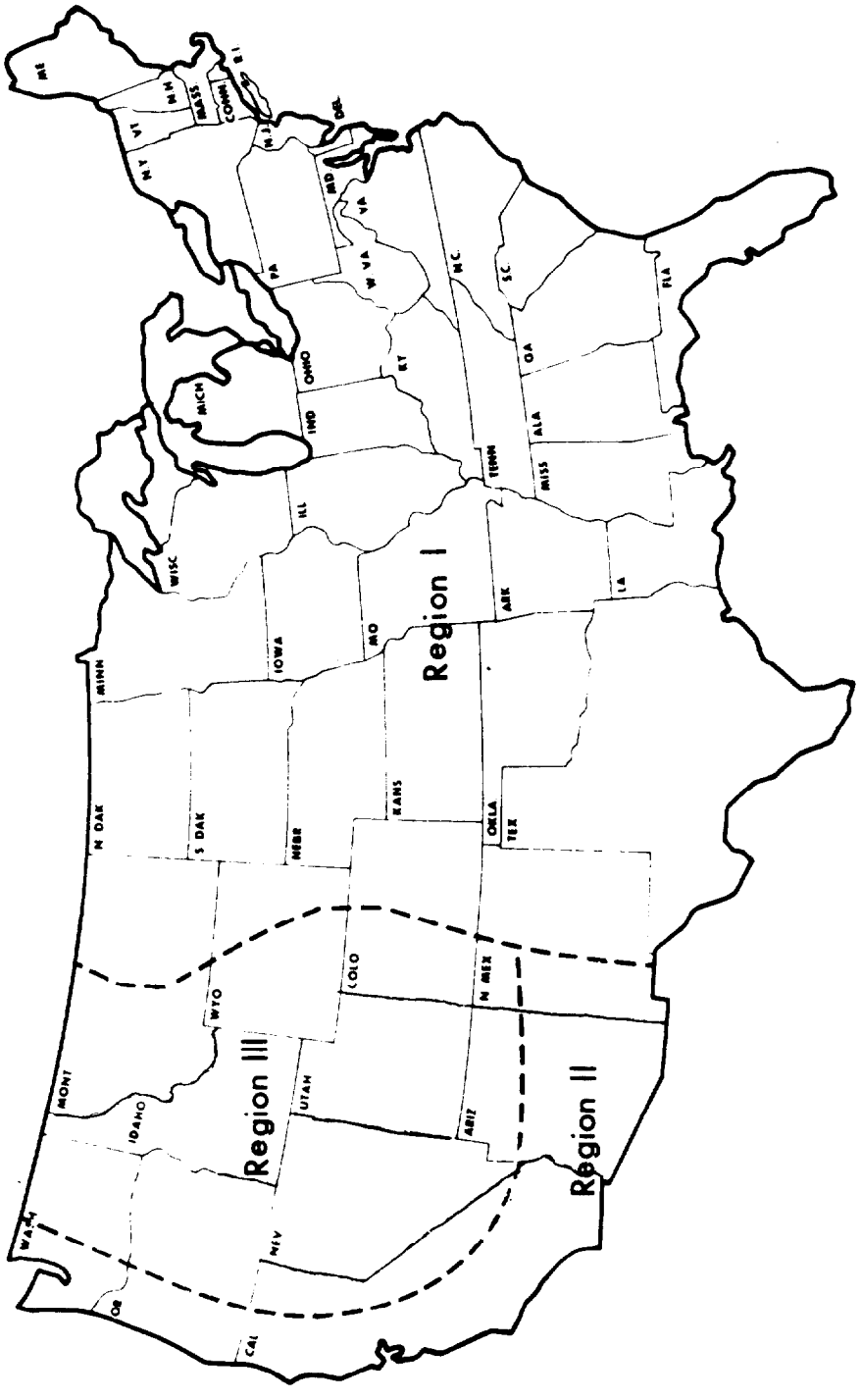
18. ACCESSIBILITY AND USABILITY BY THE PHYSICALLY HANDICAPPED.

    While, by their very nature, plutonium facilities may not generally offer opportunities for employment of physically handicapped persons within hazardous areas, proper consideration shall be given to employment opportunities in such areas as offices or other administrative or support areas. Suitable provisions should be made in these areas whenever such opportunities exist and where handicapped persons would not be subjected to undue hazards. See paragraph 13 in Chapter IV of this Order.

19. CRITERIA DEVIATIONS.

    Procedures for authorizing deviations from these criteria are contained in Chapter I of this Order.

## GEOGRAPHICAL TORNADO INTENSITY REGIONS



## DESIGN BASIS TORNADO CHARACTERISTICS

| Region | Maximum Wind Speed (mph)[2] | Rotational Speed (mph)[3] | Translational Speed (mph) | | Radius of Maximum Rotational Wind (feet) | Pressure Drop (psi) | Rate of Pressure Drop (psi/sec) |
|---|---|---|---|---|---|---|---|
| | | | Maximum | Minimum[1] | | | |
| I | 360 | 290 | 70 | 5 | 150 | 3.0 | 2.0 |
| II | 300 | 240 | 60 | 5 | 150 | 2.25 | 1.2 |
| III | 240 | 190 | 50 | 5 | 150 | 1.5 | 0.6 |

[1] The minimum translational speed, which allows maximum transit time of the tornado across exposed plant features, is to be used whenever low travel speeds (maximum transit time) is a limiting factor in design of the ultimate heat sink.

[2] The maximum wind speed is the sum of the rotational speed component and the translational speed component.

[3] The rotational speed is the vector sum of the radial and tangential speeds.

## DESIGN BASIS CHARACTERISTICS OF POTENTIAL TORNADO-GENERATED MISSILES

| Spectrum II Missile | Mass (Kg) | Dimensions (m) | Velocity (m/sec) Region I | Region II | Region III |
|---|---|---|---|---|---|
| A–Wood plank | 52 | .092 x .289 x 3.66 | 83 | 70 | 58 |
| B–6" Sch 40 pipe | 130 | .168D x 4.58 | 52 | 42 | 10 |
| C–1" Steel rod | 4 | .0254D x .915 | 51 | 40 | 8 |
| D–Utility pole | 510 | .343D x 10.68 | 55 | 48 | 26 |
| E–12" Sch 40 pipe | 340 | .32D x 4.58 | 47 | 28 | 7 |
| F–Automobile | 1810 | 5 x 2 x 1.3 | 59 | 52 | 41 |

Vertical velocities of 70% of the postulated horizontal velocities are acceptable except for the small missile, or missile C above, used to test barrier openings, which should be assumed at the same speed in all directions.

# CHAPTER XXII

## HIGH EXPLOSIVES FACILITIES

1. COVERAGE. These criteria, supplementing the basic design criteria in Chapters I through XV of this Order, establish minimum requirements for mandatory application in the siting, planning, and design of DOE high explosives (HE) facilities, with specific applicability to DOE nuclear munitions (HE-plutonium) facilities. A basic safety philosophy of the design criteria in this Chapter XXII, and one that needs to be kept in mind in their application, is that enunciated in Chapter 16 of the DARCOM-R 385-100: "The cardinal principle to be observed in any location or operation involving explosives, ammunition, severe fire hazards, or toxic materials is to limit the exposure of a minimum number of personnel, for a minimum time, to a minimum amount of hazardous material consistent with safe and efficient operations."

   a. These criteria shall be followed in:

      (1) Siting, planning, and design of any new facilities in which HE are stored, handled, or processed.

      (2) Redesign of any existing facilities where changes in activities will result in a change to a more hazardous class (e.g., a change from Class II to Class I.) Where changes in activities will not result in a change to a more hazardous class, these criteria should be followed where technically and economically feasible.

   b. These design criteria are not applicable to:

      (1) Portable buildings used at specific nuclear test shot locations.

      (2) Facilities in which experimental or laboratory-type operations are conducted and where no more than 500 grams of HE are involved, as further described in (a) and (b), below. Such operations include, but are not limited to small scale formulation work; chemical, physical, and thermal analysis; and sensitivity tests.

         (a) Such facilities are exempt where operations involving HE in quantities of 10 grams or less (plutonium may be present) are conducted under DOE operating contractor-approved standard operating procedures (SOPs).

         (b) Such facilities are exempt where operations involving HE in quantities between 10 and 500 grams (plutonium shall not be present) are conducted, subject to formal exemptions approved by the DOE operating contractor safety organization and issued in writing by the operating contractor management.

(c) For either (a) or (b), above, the DOE field organization having jurisdiction shall be advised of any exemptions given.

2. OBJECTIVES. The objectives of these criteria are to assure that facility design will:

a. Achieve a level of safety for DOE HE facilities, greater than that provided DARCOM-R 385-100, in order to prevent fatalities and reduce injuries to personnel, as well as limit propagation from accidental detonation and minimize property loss.

b. Incorporate additional safety requirements for DOE HE-plutonium facilities, which are not addressed in DARCOM-R 385-100.

3. CODES, STANDARDS, AND GUIDES. In addition to applicable codes, standards, and guides identified in the basic design Chapters I through XV of these general design criteria, the latest editions of those listed below shall also be followed:

a. DOE/EV/06194-1, "DOE Explosives Safety Manual," of 6-82.

b. Department of the Army Technical Manual TM 5-1300, "Structures to Resist the Effects of Accidental Explosions."

c. Department of the Army Material and Readiness Command Regulation, DARCOM-R 385-100, "Safety Manual."

d. Department of Defense (DOD) "Ammunition and Explosives Safety Standards," DOD 5154.4S.

e. DOE/TIC-11268, "A Manual for the Prediction of Blast and Fragment Loading on Structures."

f. American National Standards Institute (ANSI) Standards:

(1) A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

(2) N42.18, "Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioactivity in Effluents."

(3) ANSI/ANS 8.3, "Criticality Accident Alarm Systems."

(4) N101.6, "Concrete Radiation Shields."

(5) N512, "Protective Coatings (Paints) for the Nuclear Industry."

g. DOE-DNA TP 20-7, "Nuclear Safety Criteria." (Classified)

4. DOE DIRECTIVES. Other DOE Directives (Orders) to be followed include latest editions and changes to those listed below.

   a. DOE 5480.1A, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS, of 8-13-81.

      (1) Chapter I, "Environmental Protection, Safety, and Health Protection Standards," of 8-13-81.

      (2) Chapter III, "Safety Standards for the Packaging of Fissile and Other Radioactive Materials," of 5-1-81.

      (3) Chapter V, "Safety of Nuclear Facilities," of 8-13-81.

      (4) Chapter VII, "Fire Protection," of 12-18-80.

      (5) Chapter XI, "Requirements for Radiation Protection," of 4-29-81.

      (6) Chapter XII, "Prevention, Control, and Abatement of Environmental Pollution," of 12-18-80.

   b. DOE 5481.1A, SAFETY ANALYSIS AND REVIEW SYSTEM, of 8-13-81.

   c. DOE 5484.2, UNUSUAL OCCURRENCE REPORTING SYSTEM, of 8-13-81.

   d. DOE 5610.1, PACKAGING AND TRANSPORTING NUCLEAR EXPLOSIVES, NUCLEAR COMPONENTS, AND SPECIAL ASSEMBLIES, of 9-11-79.

   e. DOE 5610.3, PROGRAM TO PREVENT ACCIDENTAL OR UNAUTHORIZED NUCLEAR EXPLOSIVE DETONATIONS, of 12-18-80.

   f. DOE 5630.1, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, of 8-3-79.

   g. DOE 5630.2, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, BASIC PRINCIPLES, of 8-21-80.

   h. DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER, of 7-18-79.

   i. DOE 5632.2, PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS, of 2-16-79.

   j. DOE 5700.6A, QUALITY ASSURANCE, of 8-13-81.

   k. DOE 4300.1A, REAL ESTATE (REAL PROPERTY) MANAGEMENT, of 7-7-83.

   l. DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING, of 3-17-83.

5. DEFINITION OF TERMS.

   a. Accident (Explosive). An incident or occurrence which causes any uncontrolled chemical reaction involving HE.

b. Cased High Explosives. High explosives which are enclosed in a physical protective covering which will retain the HE securely and will offer significant protection against accidental detonation during approved handling and intraplant transportation operations.

c. Design Basis Accidents. The postulated accidents and resulting conditions for which the structure, systems, and equipment must meet their functional goals.

d. Detonation or Explosion. A violent chemical reaction within a chemical compound or mixture evolving heat and pressure. (Technically, a detonation, as compared with an explosion or deflagration, is a reaction which proceeds through the reacted material at a supersonic velocity. This results in the exertion of extremely high pressures on the surrounding medium, forming a propagating shock wave of supersonic velocity. However, for the purposes of these criteria the terms detonation and explosion will be used interchangeably regardless of the velocity of the reaction or propagating shock wave.)

e. High Explosives (HE). Explosives capable of mass detonation when initiated. They may burn without detonation. They may further be classified as primary or secondary high explosives based upon sensitivity to initiation by heat, friction, shock, and so forth.

f. High Explosives Activity. Each function (storage, handling and processing) involving high explosives from the manufacture or receipt of the HE through the final shipping configuration, including final storage but excluding the movement of HE between HE areas.

g. High Explosives Bay. A location (room, cubical, cell, work area, containing a single type of HE activity which affords the required protection for the appropriate hazard classification (Class I, II, or III as defined in paragraph i., below) of the HE activity involved. Examples of such HE activities are: operator-attended machining, pressing, meltcasting, nondestructive testing, and assembly operations.

h. High Explosives Building. Any structure containing one or more high explosives bays.

i. High Explosives Hazard Classes. The level of protection required for any specific HE activity is based on the hazard class (accident potential) for the HE activity involved. Three hazard classes are defined for HE activities as follows:

(1) Class I. Class I consists of those HE activities involving a high potential for an accident which is unacceptable for the exposure of any personnel, thus requiring remote operations. In general, this would include activities where the energies which may interface with the HE are approaching the upper limits of safety, and/or loss of

control of the energy is likely to exceed the safety limits for the HE involved. This category includes those research and development activities where the safety implications have not been fully characterized. Examples of Class I activities are screening, blending, pressing, extrusion, drilling of holes, dry machining, some wet machining, machining HE and metal in combination, development of some new HE or HE processing methods, and HE disposal.

(2) Class II. Class II consists of those HE activities which involve a moderate potential for an accident because of the type of HE, the condition of the HE and/or the nature of the operations involved. This category consists of activities where the accident potential is greater than Class III but the exposure of personnel performing contact operations is acceptable. Included are activities where the energies which do or may interface with the HE are normally well within the safety boundaries for the HE involved but where the loss of control of these energies might approach the safety limits of the HE. Examples of Class II activities are weighing HE, wet machining some HE, assembly and disassembly, environmental testing.

(3) Class III. Class III consists of those HE activities which represent a low potential for an accident because of the type of HE, the conditions of the HE and/or the nature of the activity involved. Class III includes HE activities where the accident potential of the operation being performed is not significantly different from He storage. Examples are normal handling, storage, packaging, unpackaging, and some inspection and nondestructive testing.

j. Intraline Separation (unbarricaded). The minimum quantity-distance separation permitted between HE buildings on a plant site unless equivalent protection to personnel and property is provided by building design and construction, and as noted in paragraph k., below. This distance (corresponding to approximately 3.5 psi peak overpressure) shall be determined based on the maximum explosives weight, using the tables in DOD 5154.4S.

k. Intraline Separation (barricaded). The minimum quantity-distance separation permitted between buildings as described in paragraph j., above, when an effective barricade (as defined in DOD 5154.4S) is interposed between buildings. This distance is one-half the unbarricaded intraline separation. This distance (corresponding to approximately 10-11 psi peak overpressure) shall be determined based on the maximum explosives weight, using the tables in DOD 5154.4S.

l. Inhabited Building Separation. The minimum distance separation permitted between any HE building and an installation boundary, between adjacent HE plants or operating lines, and between HE buildings and concentrations of personnel in non-HE facilities such as administrative offices, shops, warehouses, inspection and test facilities laboratories, and so forth.

This distance (corresponding to approximately 1.2 psi peak over pressure) shall be determined based on the maximum explosives weight, using the tables in DOD 5154.4S.

m. Magazine. An explosives storage structure located in a storage area. It is usually a reinforced concrete arch (igloo) or steel arch, earth-covered structure. A storage area containing magazines shall be located at not less than inhabited building separation from other areas, such as operational HE buildings, administrative-office buildings, shops and installation boundaries. (See paragraph 1, above.)

n. Magazine Separation. The minimum quantity-distance separation between magazines (not including service magazines) within a storage area. Siting of magazines within a storage area with respect to one another and location of facilities such as guard shelters and loading docks in storage areas are covered in DOD 5154.4S. Maximum explosives weight shall be used in determining separation distances.

o. Overpressure. The Maximal Effective Pressure is the highest of (1) the peak incident pressure, (2) the incident plus dynamic pressure, or (3) the reflected pressure (Ref. TM 5-1300).

p. Quantity-Distance. The quantity of explosives and the distance separation relationship which provides defined types of protection. These relationships are based on levels of risk considered acceptable for a stipulated exposure and are tabulated in the appropriate quantity-distance tables in DOD 5154.4S. Separation distances should be considered minimum distances; greater distances should be used whenever practicable.

q. Service Magazine. An auxiliary building of an operating line used for the intermediate storage of HE within the operational plant area. The amount of HE is normally limited to a maximum consistent with intraline separation from other HE buildings based on the quantity of explosives in the service magazine.

r. Support Building. Any structure (including utilities) directly supporting HE activities but containing no explosives.

s. TNT Equivalent. A measure of the blast effects from explosion of a given quantity of material expressed in terms of the weight of TNT which would produce the same blast effects when detonated. For safety and design purposes, a reasonable value can be obtained by substituting a measurement of energy release for blast effects.

t. Transient. Any person within inhabited building distance but not inside an HE bay.

6. PLANT FEATURES.

a. General.

(1) The design and siting of all new HE buildings shall conform to the standards and criteria established in Chapter I, "Environmental Protection, Safety, and Health Protection Standards," of DOE 5481.1A; the DOE Explosives Safety Manual; TM 5-1300; and these criteria. Where conflicts exist, the DOE Explosives Safety Manual and these criteria shall take precedence. For a tabular summary of the types of protection established by these criteria, see Attachment XXII-1.

(2) Siting studies necessary to provide the technical basis for location, engineering, design, and operation (under normal and potential accident conditions) of the buildings shall follow DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING and site planning guidelines of TM 5-1300. Also see DOE 4300.1A, REAL ESTATE MANAGEMENT, on procedures and requirements for new site selections.

(3) For an unproven facility design, either a validated model or full-scale testing is required to assure structural adequacy unless a high degree of confidence can be provided by calculations or other means. The contract administrator shall concur in any determination regarding testing requirements.

(4) The appropriate design basis accident(s) shall be postulated and the design of new HE buildings shall assure that the structure, confinement system(s), ventilation systems, fire suppression/ detection systems, and so forth, will meet the conditions imposed by the consequences of the postulated accident(s).

(5) New facilities shall be designed and constructed to accommodate the highest hazard class activity for which they are to be used. Where an activity can be assigned to more than one hazard class, the facility shall be designed and constructed to meet the criteria of the most stringent hazard class unless it can be determined that the projected use of the facility, during its expected life, will not exceed the criteria for a lower hazard class.

(6) The contract administrator shall be responsible for approving the hazard classification of all HE activities prior to the design of the facilities in which the activities are to be conducted.

(7) Support buildings are not specifically addressed in these criteria since the degree of protection afforded must be based on the function housed and its effect on the accomplishment of the mission of the installation. Siting of support buildings shall conform to the requirements of DARCOM-R 385-100.

b. Facility Design.

(1) High Explosives Bays (Storage, Handling and Processing). In the planning of HE activities to be performed and in the design of HE bays to satisfy these activity requirements, a basic tenet shall be to limit HE activity hazards exposure to a minimum number of personnel. Additionally, each bay housing an HE activity shall have levels of protection based on the hazard class determined for the activity, as defined in paragraph 5i, above. The levels of protection may be accomplished by equipment design, structural design, and/or the provision of operational shields as defined in the DOE Explosives Safety Manual. The levels of protection required for each hazard class are as follows:

(a) Class III. Bays for Class III (low accident potential) activities shall provide protection from explosion propagation from bay to bay within buildings and between buildings which are located at intraline or magazine distance. Minimum separation distances may be reduced when HE bays are designed to adequately contain the effects of an accident (blast pressures and missiles).

(b) Class II. Bays for Class II (moderate accident potential) activities shall, in addition to complying with the requirements for Class III bays, include design to prevent fatalities and severe injury to personnel in all occupied areas other than the bay of occurrence. For the purpose of this Class II category, access ramps and plant roads are not considered occupied areas. Prevention of fatalities and severe injuries is satisfied where personnel in occupied areas other than the bay of occurrence will not be exposed to:

1 Overpressures greater than 15 psi Maximal Effective Pressure. (This value is from Chapter 3, Section III of TM 5-1300, and is one-half of the threshold for lung damage.)

2 Structural collapse of the building in the event of an explosion in the HE bay.

3 Missiles.

(c) Class I. Bays for Class I (high accident potential) activities shall, in addition to complying with the requirements for Class II bays, provide protection to prevent serious injuries to all personnel, including personnel performing the activity, personnel in other occupied areas, and all transient personnel. This protection may be achieved by controlling debris through suppression, containment, and so forth, or by establishing an exclusion area with positive access control. Prevention of serious injuries is satisfied where personnel will not be exposed to:

1 Overpressures greater than 5 psi Maximal Effective Pressure. (This value is from Chapter 3, Section III of TM 5-1300, and is the threshold for eardrum rupture, and should not exceed 2.3 psi Peak Positive Incident Pressure.)

2 Structural collapse of the building.

3 Missiles.

(2) Bays for Joint HE-Plutonium Activities. Bays for joint HE-plutonium activities shall comply with the requirements of paragaph 6b(1), above, for the class of HE activity involved and DOE-DNA TP-20-7. Additionally, because of the plutonium contamination potential, they shall comply with the following:

(a) Bays for Uncased HE-Plutonium Activities. Where it is necessary to store, handle, or process uncased HE components in the same bay with plutonium, the enclosing structure and its associated ventilation, electrical, fire protection, and utility systems shall be designed to assure that in the event all the HE present should detonate, no individual on site or off site is likely to receive an exposure in excess of the DOE limits specified by paragraph 3i (5) Chapter 1 from the standpoint of hypothesized accidental releases. The quantity of plutonium allowed in such a bay will be governed by criticality control considerations, and the HE limits such that the above exposure criteria are met.

(b) Bays for Cased HE-Plutonium Activities. Where it is necessary to handle or process cased high explosive components that contain plutonium, the enclosing structure shall be designed as a Class II HE bay. Storage shall conform to Class III requirements. The limit of plutonium shall be 25 kilograms per bay. The plutonium limits for magazines are specified in DOE-DNA TP-20-7.

(3) Design for Protection Against Natural Phenomena.

(a) General. These criteria cover requirements for additional protection from natural phenomena for HE-Pu bays. Bays involving the coincident storage, handling, or processing of HE and plutonium, whether the HE is cased or not, are considered sensitive operations with respect to the potential hazards from high winds, tornadoes, and seismic phenomena. Structures, systems, and associated equipment involved in these activities shall be designed to protect the HE from the loads induced by such forces, including missile loads. The application of these criteria shall not have an adverse effect upon the explosion protection design features of the structure. The degree of protection afforded HE (only) bays and support buildings shall be based on a determination of the function housed and its effect on the accomplishment of the mission of the installation.

(b) Tornado, Seismic and Other Natural Phenomena. These criteria shall be used in the design of structures to protect the HE from any natural forces which may cause an explosion.

1 Tornado.

a In designing bays for joint HE-plutonium activities, use shall be made of the site-specific tornado hazard curves, available from the Headquarters Office of Nuclear Safety, in selecting the appropriate tornado windspeed magnitude to be applied. Where a tornado hazard curve is unavailable for a particular site, or deemed inappropriate, then the geographical intensity regions and the associated design basis tornado characteristics shown in Attachments XXI-1 and XXI-2, respectively, of Chapter XXI (Plutonium Facilities) shall be used; unless it can be demonstrated by a detailed evaluation on a case-by-case basis that lesser values pertain to a given site and Headquarters approval is obtained to design for these lesser values. See paragraph 7a(2)(a) of Chapter XXI (Plutonium Facilities) for additional details. Procedures for requesting Headquarters approval are contained in paragraph 2d, Chapter I of this Order. Structures shall be designed for tornado forces to prevent the detonation of any HE. Some structural damage is acceptable as long as a detonation is prevented.

b The design basis tornado should be assumed possible of occurring at any time, except that the simultaneous occurrence with another design basis accident or with any other limiting site related event, such as an earthquake, fire, or flood, need not be considered for design purposes unless the incident or event, such as fire, might be an expected consequence of a tornado.

2 Seismic.

a Design parameters for earthquake protection shall be developed for the site by an analysis of the site conditions and the probable maximum seismic parameters. The seismic loading shall not be less than that specified in the Uniform Building Code.

b The design basis earthquake shall be assumed possible of occurring at any time except that the simultaneous occurrence with another design basis accident or with any other limiting site related event, such as a tornado, fire, or flood, need not be considered for design purposes unless an incident or event, such as fire, might be expected as a consequence of an earthquake.

3 Other Natural Phenomena.

a Flooding. Protection against flooding shall be based on no less than the probable maximum flood for the area as defined by the Corps of Engineers.

b Wind, Snow, and Ice. Design loads and considerations for wind, snow, and ice shall be greater than the maximum historical level recorded for the site to provide a conservative margin of safety. Wind loading criteria shall in no case be less than that required by ANSI Standard A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures," for 100 year mean recurrence level. See Chapter IV of this Order.

c Lightning. Lightning protection should be provided for all buildings containing HE bays. An assessment of need for lightning protection shall be conducted using the criteria in paragraph 6, Chapter VIII of this Order, and and NFPA 78, "Lightning Protection Code," Appendix B. Installation of protection systems shall be in accordance with the requirements of DARCOM-R 385-100, Chapter 8, "Lightning Protection," or other DOE-approved systems. In addition, lightning arresters on the primary side of electrical supply systems to HE buildings shall be of the intermediate valve type.

(4) Waste Management and Environmental Contamination Control. Provisions shall be made for the control and proper disposition of all wastes (solid, liquid, and gaseous) and potential environmental contaminants in accordance with the requirements in Chapters XI and XII of this Order, Chapters I, XI, and XII of DOE 5480.1A, and DARCOM-R 385-100.

(5) Fire Protection. The hazards from fire in buildings (except magazines) containing high explosives and plutonium are such as to require the installation of automatic fire suppression systems. For buildings containing only HE, fire suppression systems are required as dictated by DOE loss criteria and mission requirements. Additional protection, such as automatic deluge systems, shall be provided where appropriate. Advice and guidance shall be obtained from cognizant DOE fire protection personnel during the planning and design of HE facilities to assure that necessary protection is provided. Where fire suppression is required, each HE bay shall have an individual feed with controls protectively located outside the bay. The design of the fire suppression systems shall be in accordance with Chapter X of this Order, and the minimum requirements in DARCOM-R 385-100. In addition, early warning fire detection shall be considered and provided where such early warning might reasonably aid in prevention or mitigation of an accident. Transmitted alarms shall distinguish between HE and non-HE areas through the use of annunciator panels at safe locations.

(6) Other Design Features.

(a) High Explosives Design Basis.

1 Blast resistant design for personnel and facility protection shall be based on the TNT equivalency of the maximum quantity of HE to be used in the bay. For example, based on heat of detonation, one pound of one of the most energetic plastic-bonded explosives is equivalent to 1.3 pounds of TNT. It is recommended by TM 5-1300 that the "effective charge weight" or the "actual charge weight," depending upon the method used to determine the TNT equivalent, be increased by 20 percent for design purposes.

2 For total containment facilities, the internal gas pressure produced in an accident may be the controlling design requirement rather than blast pressure. For internal pressure calculations, the TNT equivalency for blast pressures may not be applicable.

(b) Electrical. For the purpose of fixed electrical installations, all HE bays shall be considered National Electrical Code Class II, or Class I and II, hazardous locations as defined in DARCOM-R 385-100, Chapter 6. Determination of specific electrical design requirements for each HE bay shall be made on a case-by-case basis by the field office having jurisdiction based upon the types of HE activities to be performed. Operating equipment used in the bay shall be evaluated and rated on an individual basis.

(c) Flooring. In addition to the requirements of DARCOM-R 385-100, Para. 5-3, and Chapter 7, a resilient floor covering shall be installed in all HE bays (including HE-Pu bays) where uncased HE components are handled. The resilient floor covering used shall be one which has been found to be acceptable in either the Los Alamos National Laboratory (LANL) or the Lawrence Livermore National Laboratory (LLNL) skid tests. Information may be obtained from the WX Division, LANL or the Hazards Control Department, LLNL.

(d) Utilities. The design of utility services for HE facilities shall be in accordance with DARCOM-R 385-100 and provide reliability consistent with operational requirements, value, and potential hazard.

(e) Decontamination Requirements.

1 Design of new facilities shall include provisions for future decontamination and decommissioning.

2 Installations handling HE and radioactive material shall have a personnel decontamination facility for emergency use. Minimum requirements shall include sinks, showers, and change area. Provisions shall be made for radiation monitoring equipment to be located in the decontamination room and at specified locations where workers exit from potentially contaminated areas.

(7) Special Radiological Design Requirements. These design requirements are to be applied specifically where HE and plutonium are present in the same bay (except magazines) and shall be in addition to requirements and practices associated with the use of other radioactive materials such as uranium and tritium.

(a) Floors and Surfaces. In addition to the requirements in paragraph (6)(c), above, ease of radiological decontamination shall be provided for in the selection of floor and wall coverings. Where paints are to be used, they shall comply with the specifications as contained in ANSI Standard N512, "Protective Coating (Paints) for the Nuclear Industry." To the extent practicable, floor-to-wall interfaces shall be coved for ease of decontamination.

(b) Ventilation. The ventilation requirements apply, in the context of radiological safety, to two types of accidents: first an explosion wherein the total ventilation system of the remaining facility and other nearby facilities would be immediately shut down to prevent entry of airborne radioactivity released to the environs and, secondly an accident less severe than an explosion wherein structural damage would be at a minumum or nonexistent and airborne radioactivity would be the prime concern. The following radiological criteria shall be incorporated into design of ventilation systems:

1 The ventilation system in the affected area shall be designed to permit immediate shutdown in the event of an explosion. The system shall permit automatic and manual shutdown.

2 To minimize the spread of contamination from accidents less severe than an explosion, supply and exhaust air shall be filtered to assure that airborne releases to the environs or other commonly supplied areas do not exceed the concentration guides specified in Chapter XI of DOE 5480.1A. Air supply flows shall be directed toward the area(s) of the highest potential concentration.

(c) Air Monitoring. Continuous air monitoring systems shall be provided in work locations for contamination detection. The systems shall be equipped with audio and visual alarms at both the immediate work location and a location external to the immediate area. The detection system(s) shall be sensitive to nuclides associated with the operation. System performance shall be consistent with the current state of the art, as follows:

1 Effluent monitoring system shall comply with minimum levels of detectability and total performance as specified in ANSI Standard N42.18, "Specification and Performance of On-Site Instrumentation for Continuously Monitoring Radioacivity in Effluents."

2 Plutonium detection sensitivity should be equivalent to 8 RCG (Radiation Concentration Guide) hours or less.

3 Tritium detection sensitivity should be 1 RCG or less.

(d) Concrete radiation shielding should be in accordance with ANSI Standard 101.6, "Concrete Radiation Shields."

(8) Nuclear Criticality. Where nuclear criticality is a consideration, the design of criticality alarm systems shall comply with the specifications contained in ANSI/ANS 8.3. Other nuclear criticality safety measures shall comply with requirements of Chapter V of DOE 5480.1A, and DOE-DNA TP 20-7.

(9) Physical Protection and Material Safeguards. The design of high explosives facilities shall comply with the requirements of DOE 5630.2, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, BASIC PRINCIPLES, of 8-21-80; DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER; and DOE 5632.2, PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS. Advice and guidance shall be obtained from cognizant DOE safeguards and security personnel during the planning and design of HE facilities to assure that necessary physical protection and material safeguards features are being provided.

7. QUALITY ASSURANCE. A quality assurance (QA) program shall be developed and implemented for high explosive facility projects to satisfy the objectives and requirements contained in Chapter I of this Order.

8. SAFETY ANALYSIS. In the planning and design of any new facilities in which HE are stored, handled, or processed, or in the redesign of existing facilities, a saftey analysis shall be performed consistent with the requirements of DOE 5481.1A, SAFETY ANALYSIS AND REVIEW SYSTEM and Chapter V, "Safety of Nuclear Facilities," of DOE 5480.1A.

a. The safety analysis shall be initiated early in the project planning phase. It is important that the analysis be sufficiently complete and documented, for review and approval, as early as practicable during conceptual design of the facility, such that the design basis accident parameters and other principal design bases, operational and occupational health and safety requirements, and the necessary facility design and construction features are adequately identified. Estimated costs of construction features shall be factored into the conceptual design prior to establishing the project cost estimate and requesting Congressional authorization for design and construction.

b. The preliminary safety analysis report (PSAR) should be completed during the conceptual design phase, or at least prior to the start of detailed (Title II) design work. The PSAR serves as an important management tool in the design decision making process.

c. The safety analysis report (SAR) shall be finalized prior to initial facility operation, and made a part of the permanent project/operating records. It shall be updated as appropriate to reflect changes affecting safety which are made to the facility during its lifetime.

d. Typical elements to be addressed in safety analysis (and in the Safety Analysis Report) are identified in paragraph 3b(2) in Chapter I, of this Order.

9. ACCESSIBILITY AND USABILITY BY THE PHYSICALLY HANDICAPPED. While, by their very nature, high explosives facilities may not generally offer opportunities for employment of physically handicapped persons within the hazardous areas, proper consideration shall be given to employment opportunities in such areas as offices and other administrative or support areas. Suitable provisions shall be made in these areas wherever such opportunities exist and where handicapped persons would not be subjected to undue hazards. See Chapter IV of this Order.

10. CRITERIA DEVIATIONS. Procedures for authorizing deviations from these criteria are contained in Chapter I of this Order.

## PROTECTIVE DESIGN REQUIREMENTS BY TYPE OF ACTIVITY

| Protective Design Required | Type of Activity | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Class I HE | | | Class II HE | | | Class III HE | | | |
| | HE Only | HE-Pu* Cased | HE-Pu* Uncased | HE Only | HE-Pu Cased | HE-Pu Uncased | HE Only | HE-Pu Cased | HE-Pu Uncased | Support Area |
| DARCOM-R 385-100 Requirements For Activity Involved | X | NOT PERMITTED | NOT PERMITTED | X | X | X | X | X | NOT PERMITTED | X |
| Explosion Protection For Personnel in Other Occupied Areas Including Adjacent Bays | X | | | X | X | X | | | | |
| Explosion Protection For All Personnel (Remote Operation) | X | | | | | | | | | |
| Control of Plutonium In The Event of An Explosion | | | | | | X | | | | |
| High Level Protection From Natural Phenomena | | | | | X | X | | X | | |
| Normal Protection From Natural Phenomena | X | | | X | | | X | | | X |
| Radiological Considerations | | | | | X | X | | | | |

*NOTE: Class I activities with either cased or uncased HE-Pu are not normally permitted, except where such activities are justified from a nuclear explosives safety study performed in accordance with DOE 5610.3, PROGRAM TO PREVENT ACCIDENTAL OR UNAUTHORIZED NUCLEAR EXPLOSIVE DETONATION.

# CHAPTER XXIII

# UNIRRADIATED ENRICHED URANIUM STORAGE FACILITIES

1. COVERAGE.

   a. These criteria, supplementing the basic design criteria in Chapters I through XV of these general design criteria, establish minimum requirements for mandatory application in the planning and design of new facilities that are to be used for the storage of unirradiated enriched uranium (enriched in the isotope U-235) where the enrichment level is more than 5 percent by weight. These criteria are also applicable to lower enrichment levels where potential safety hazards (i.e., radiation criticality) may exist.

   b. These criteria are not applicable to "in-process" or "in-use" material; to material in assembly cells for use in weapons or peaceful nuclear explosives; or to material which is packaged in accordance with the requirements of Chapter III of DOE 5480.1A and is awaiting transportation or received and awaiting disposition.

2. DEFINITION OF TERMS (for purposes of these criteria).

   a. Approved Storage Container. A container fabricated from noncombustible material(s); that satisfies container integrity criteria, developed from the safety analysis for the particular form(s) of stored material, under normal storage conditions, design basis fire and other design basis accident conditions; and that is approved for its intended use by the responsible DOE operating contractor and the responsible DOE field organization.

   b. Design Basis Accidents (DBA's). Postulated accidents, or natural forces, and resulting conditions for which the confinement structure, systems, and equipment must meet their functional goals.

   c. Design Basis Earthquake, Tornado, Explosion or Fire. The most severe DBA of that type applicable to the area under consideration.

   d. In-Process or In-Use Material. Material which is integral to the manufacturing or production processes and is needed to maintain continuity of operations. Other material which requires temporary location near the pertinent process areas in readiness for near-term use or for movement to other process areas may also be considered "in-process." For material involved in laboratory operations, analogous definitions shall be applied to determine eligibility for the "in-process" or "in-use" category and consequent exclusion from storage requirements of these criteria.

e. New Storage Facility. A newly constructed facility or the conversion of existing facility, or portion of an existing facility, for use as an unirradiated enriched uranium storage facility.

f. Physically Separated. Set apart by fences, walls or similar obstructions.

g. Unirradiated Enriched Uranium. Naturally occurring uranium enriched to more than 5 percent (weight percent) of U-235 and which contains no other sources of radioactivity in amounts that are subject to licensing regulations.

3. CODES, STANDARDS, AND GUIDES. In addition to applicable codes, standards, and guides identified in the basic design Chapters I through XV of this Order, the latest editions of those listed below shall also be followed:

a. ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

b. ANSI N13.3, "Dosimetry for Criticality Accidents."

c. ANSI/ANS 8.3, "Criticality Accident Alarm Systems."

d. ANSI N101.6, "Concrete Radiation Shields."

e. ANSI N512, "Protective Coatings (Paints) for the Nuclear Industry."

f. AEC-ERDA (DOE) RDT Standard F8-6T, "Hoisting and Rigging of Critical Components and Related Equipment."

4. DOE DIRECTIVES. Other DOE directives to be followed include the latest editions and changes to those listed below.

a. DOE 5480.1A, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS, of 8-13-81.

(1) Chapter I, "Environmental Protection, Safety, and Health Protection Standards," of 8-13-81.

(2) Chapter III, "Safety Standards for the Packaging of Fissile and Other Radioactive Materials," of 5-1-81.

(3) Chapter IV, "Nuclear Criticality Safety," of 5-1-81.

(4) Chapter V, "Safety of Nuclear Facilities," of 8-13-81.

(5) Chapter VII, "Fire Protection," of 12-18-80.

(6) Chapter XI, "Requirements for Radiation Protection," of 8-13-81.

(7) Chapter XII, "Prevention, Control, and Abatement of Environmental Pollution," of 12-18-80.

b. DOE 5481.1A, SAFETY ANALYSIS AND REVIEW SYSTEM, of 8-13-81.

c. DOE 5630.1, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, of 8-3-79.

d. DOE 5630.2, CONTROL AND ACCOUNTABILITY OF NUCLEAR MATERIALS, BASIC PRINCIPLES, of 8-21-80.

e. DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER, 7-18-79.

f. DOE 5632.2, PHYSICAL PROTECTION OF SPECIAL NUCLEAR MATERIALS, of 2-16-79.

g. DOE 5700.6A, QUALITY ASSURANCE, of 8-13-81.

h. DOE 4300.1A, REAL ESTATE (REAL PROPERTY) MANAGEMENT, of 7-7-83.

i. DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING, of 3-17-83.

5. BASIS OF DESIGN.

a. A safety analysis shall be performed and documented for each new storage facility, consistent with the requirements of DOE 5481.1A, and Chapter V, of DOE 5480.1A.

(1) Preliminary safety analysis shall be initiated early in the project planning phase. It is important that the analysis be sufficiently complete and documented, for review and approval, as early as practicable during conceptual design of the facility, such that the design basis accident parameters, operational and occupational health and safety requirements, and the necessary facility design and construction features are adequately identified; and appropriately factored into the conceptual design prior to establishing the project cost estimate and requesting Congressional authorization for design and construction. Facility features to be evaluated include type of construction, safety systems, compartmentalization, storage containers, storage racks, handling equipment, and the siting of the facility.

(2) The preliminary safety analysis report (PSAR) should be prepared during the conceptual design phase, or at least prior to the start of detailed (Title II) design work. The PSAR serves as an important management tool, in the design decision making process prior to initiating detailed design.

(3) The safety analysis report (SAR) for the project shall be finalized prior to initial facility operations, and made a part of the permanent project records.

b. Typical elements to be addressed in safety analysis, and in the safety analysis reports (PSAR and SAR) are identified in Chapter I of this Order and DOE 5481.1A.

c. Reasonable assurance shall be provided that fire protection, physical protection, and nuclear material safeguards will be maintained under all credible combinations of internal accidents, external threats, and pertinent natural forces. Appropriate margins of safety and degree of conservatism shall be incorporated consistent with the potential hazards and uncertainties in defining natural phenomena.

6. GENERAL DESIGN REQUIREMENTS.

a. Location. The factors contained in DOE 4320.1A, SITE DEVELOPMENT AND FACILITY UTILIZATION PLANNING, shall be considered in determining the locations of facilities used for the storage of unirradiated enriched uranium on existing DOE sites. Also see DOE 4300.1A, REAL ESTATE MANAGEMENT, on procedures and requirements for new site selections.

b. Layout.

(1) Basic architectural criteria for planning and layout of buildings are contained in Chapter IV of this Order.

(2) Where practical, storage buildings shall be rectangular, windowless, and arranged in repetitive bays and compartments. The layout should provide for efficient cleaning, maintenance, and ease of inspection. The facility shall be designed to expedite identification, inventory, placement, and retrieval of storage containers.

(3) The design shall provide for the storage of combustible packaging materials in a container (preferably metal) or structure outside of the storage facility. The location shall be such that a fire in the packaging material will not endanger the storage facility or stored material. New storage facilities shall be physically separated from process operations, storage of nonnuclear materials or equipment, and functions not directly required for storage operations.

(4) Where floor storage is operationally required, layout of floor areas and access areas shall take into consideration the requirements for secure location of storage containers, traffic control, and segregation.

c. Compartmentalization. Suitable physical compartmentalization shall be provided, as determined from the safety analysis, to limit the quantities of stored materials in each compartment to safe levels; assure the necessary access features and controls; and satisfy the loss limitation criteria in paragraph 6e, below.

d. Personnel and Public Safety.

(1) The design of new storage facilities shall be to reduce, to as low as reasonable achievable, the probability and/or consequences of a DBA. Automatic monitoring and alarm devices shall be provided (where required by the form and potential hazard of stored material) to detect the presence of significant levels or increases of radioactivity, or any harmful non-radioactive materials, either released in the facility or escaping from it. Cautionary systems or interlocks shall prevent inadvertent entry into hazardous areas. All safety alarm systems shall annunciate inside and outside of the storage facility so as to identify hazardous areas. The need for visual alarm devices within the facility, in addition to audible alarm devices, shall be considered.

(2) Dose rates within a facility shall be minimized, to as low as reasonably achievable, by proper facility design and equipment layout. Design factors to consider include occupancy time, spacing, equipment and shielding. Personnel exposure levels, under normal operating conditions, of less than 1/5 of the permissible dose equivalent limits prescribed in Chapter XI of DOE 5480.1A shall be used as a design objective. Design objectives shall also include those factors necessary to assure that exposure to the public under normal operating conditions is maintained as low as reasonably achievable within the limits for the population as prescribed in Chapter XI of DOE 5480.1A. In the siting and design of facilities for protection of the public and operating personnel from hazards associated with DBA, including the effects of natural phenomena pertinent to the site, the requirements in paragraph 3b(1), Chapter I of this Order shall be satisified. Proper consideration shall also be given to chemical toxicity protection, as well as radiation protection. For unirradiated enriched uranium, under postulated accident conditions, chemical toxicity exposure will often be the controlling factor.

(3) Emergency exits shall be provided in accordance with National Fire Protection Association (NFPA) "Life Safety Code," NFPA 101.

e. Loss Limitations. The design shall provide sufficient structural integrity, fire resistance, compartmentalization, detection systems and alarms (plus other engineered safety systems where required) necessary to generally limit property loss from any single DBA (excluding earthquakes and tornadoes): to less than $1 million for those facilities in which safety systems are provided and function properly, and to less than $25 million where safety systems do not function properly. See Chapter X, this Order and Chapter VII of DOE 5480.1A, for "maximum possible fire loss" criteria.

f. Surveillance, Inspection, and Testing. Design shall be such as to facilitate periodic inspections and in situ tests which will be necessary

to demonstrate that safety and emergency systems are being properly maintained in readiness for use.

g. Decommissioning. The design shall be such as to facilitate decontamination in the event of future decommissioning.

7. PHYSICAL PROTECTION AND MATERIAL SAFEGUARDS. Adequate material safeguards and physical protection shall be provided in accordance with the requirements of DOE 5630.2, DOE 5632.1, and DOE 5632.2, to prevent unauthorized access to and unauthorized removal or diversion of stored material, facilitate detection of such removal, and prevent significant damage from credible external threat. Specific requirements for physical protection as set forth in DOE 5632.2, and for materials control and accountability as set forth in DOE 5630.2, are mandatory for the quantities and enrichments of materials as specified therein.

8. SOURCE AND SPECIAL NUCLEAR MATERIAL. The design may provide for the storage of source and special nuclear material (SNM) if these materials are considered in the safety analysis and the criteria for the most hazardous material is applied. When source or SNM is to be stored along with enriched uranium, approved storage containers and simple physical barriers shall be used to segregate materials and provide a level of confinement and safety consistent with the hazard of the added material.

9. ARCHITECTURAL-STRUCTURAL.

a. General Requirements. Architectural and structural design shall conform to the criteria in Chapter IV of this Order.

b. Access. Location of doors shall be coordinated with the location of aisles to facilitate access to stored material, loading and unloading of material, and use of firefighting equipment. Bumpers shall be provided where necessary to minimize damage potential to the structure or racks from handling equipment.

c. Materials. Storage buildings shall be so designed and constructed as to maintain structural integrity in any credible fire. Materials of construction shall be fire-resistive or noncombustible to the maximum extent practicable. Alternative construction materials may be used only where shown permissible from the safety analysis, and approved by the DOE safety authority having jurisdiction. External walls and roof shall have at least a two-hour fire rating and interior partitions shall have at least a one-hour fire rating. In the selection of surface coatings for walls and floors, consideration should be given to combustibility and fire retardant characteristics and ease of cleaning and decontamination. Concrete radiation shielding should be in accordance with ANSI standard N101.6, "Concrete Radiation Shields."

d. Storage Containers. Unirradiated enriched uranium shall be stored in approved storage containers.

e. Storage Racks. Storage racks or equivalent equipment (such as "birdcages") shall be noncombustible and capable of securely locating stored material to keep storage containers from excessive damage, assure proper separation of storage containers, and meet safety design bases under operational and accident conditions.

f. Design Forces. In addition to normal dead and live loads, natural forces as identified in the safety analysis (such as floods, earthquakes, winds, and tornadoes) shall be assessed in defining the design forces to be used in structural design.

10. MECHANICAL.

a. General Requirements. Mechanical systems design shall conform to the criteria in Chapter V of this Order.

b. Ventilation. The need for special ventilation systems for confinement purposes shall be determined by the safety analysis. The ventilation system, if required for the storage area, shall include all necessary air cleaning equipment such as scrubbers, prefilters, high efficiency particulate air (HEPA) filters; appropriate fire protection; components of criticality prevention; explosion protection; and emergency power, sufficient to provide reliable operation and to achieve the design objectives for confinement. Adequate dampers shall be located so that significant cross contamination will not occur in case of a localized release of material. Filter systems shall be designed for ease of maintenance, and for recovery of uranium in case of accident.

11. ELECTRICAL.

a. General Requirements. Electrical systems design shall conform to the criteria in Chapter VI of this Order.

b. Emergency Power. Emergency power, automatically activated on failure of normal supply, shall be provided for all vital lighting, safety and security features, monitors, alarms and control functions and shall be capable of performing any required functions under DBA conditions. If loss of normal power activates alarms, and operations in the storage facility are to be immediately halted and all personnel evacuated, consideration may be given to providing emergency power only to those functions necessary to maintain confinement and facilitate recovery of normal operations.

12. FIRE PROTECTION.

a. General Requirements. Fire protection design shall conform to the criteria in Chapter X of this Order.

b. Fire Suppression.

(1) Where determined to be required from the safety analysis, and the "maximum possible fire loss" criteria in Chapter X, of this Order, storage facilities shall be provided with Underwriters Laboratories' listed or Factory Mutual approved automatic fire suppression systems to maintain confinement of stored material, minimize propagation of fires, and prevent loss of life and undue economic loss. Such systems shall be designed to minimize probability of failure as a result of any credible accident. Unless otherwise justified, wet pipe sprinkler systems shall be used. System activation alarms shall be transmitted to continuously occupied locations. Monitoring systems shall announce the occurrence of failure or disablement in the system. Utility service connections shall be provided to facilitate manual fire suppression. Provisions shall be made for any auxiliary firefighting equipment and self-contained breathing apparatus which may be required in the facility.

(2) Where required from the safety analysis, storage facilities shall include features to impound materials used in fire-fighting, minimize contamination of surrounding areas, minimize loss, and allow recovery of stored materials which may be involved in a fire. Any impounding capability required, including floor drains and holding tanks, shall be designed for criticality safety and safe and efficient recovery of any enriched uranium which may be released in an emergency.

c. Fire Detection. Underwriters Laboratories' listed or Factory Mutual approved automatic fire detection systems shall be provided, including provisions for in-place testing capability. Alarms shall annunciate locally so as to be audible within storage areas and at central stations and shall indicate the specific area initiating the alarm. Monitoring systems also shall announce the occurrence of failure or disablement in the system.

13. NUCLEAR CRITICALITY PROTECTION. In the design of new enriched uranium storage facilities, nuclear criticality safety measures shall conform to Chapter V, of DOE 5480.1A, as minimum requirements.

14. QUALITY ASSURANCE. A quality assurance program shall be developed and implemented for uranium storage facility projects to satisfy the objectives and requirements contained in DOE 5700.6A, and Chapter I of this Order.

15. CRITERIA DEVIATIONS. Procedures for authorizing deviations from these criteria are contained in Chapter I of this Order.

# CHAPTER XXIV

(RESERVED)

(PLUTONIUM STORAGE FACILITIES)

To be issued

# CHAPTER XXV

## OCCUPATIONAL HEALTH FACILITIES

1. COVERAGE. These criteria, supplementing the basic design criteria in Chapters I through XV of this Order, shall be applied in the planning and design of central occupational health facilities, dispensaries, and first aid stations (excluding hospitals) for DOE industrial and research facilities to include facilities, utilizing or processing radioactive materials. While these criteria are oriented toward DOE contractor occupational health facilities, these facilities are also usable by DOE employees (and transient visitors to DOE sites) for emergency or first aid treatment.

2. CODES, STANDARDS, GUIDES, AND DOE DIRECTIVES. In addition to applicable codes, standards, guides, and other DOE directives identified in the basic design Chapters I through XV of this Order, the latest editions and changes to those listed below shall also be followed.

   a. National Safety Council," Accident Prevention Manual for Industrial Operations."

   b. DOE 5480.1A, ENVIRONMENTAL PROTECTION, SAFETY, AND HEALTH PROTECTION PROGRAM FOR DOE OPERATIONS, of 8-13-81; Chapter VIII, "Contractor Occupational Medical Program."

   c. DOE 3790.1, OCCUPATIONAL SAFETY AND HEALTH PROGRAM FOR FEDERAL EMPLOYEES, of 12-11-80.

3. PLANNING. In the planning of a new occupational health facility, the estimated case load shall be developed in collaboration with the operating group. In addition, the available nearby community medical facilities shall be evaluated and the requirements in Chapter VIII, DOE 5480.1A shall be followed. Ordinarily, unique problems associated with health hazards involving radioactive materials cannot be handled by a community facility.

   a. Occupational health facilities shall be planned and designed to provide the required services efficiently and at minimum cost. Several elements of design and finish for these facilities will be of a higher class than for administrative facilities because of illumination, ventilation, sanitation, contagion, and cleanliness requirements.

   b. In addition to the usual occupational health facilities, where radioactivity is a factor and an adequate community facility is not available, provisions shall be made for emergency minor surgical, decontamination, and lifesaving medical care for personnel casualties or injuries resulting from contamination by radioactive substances.

c. Size and location of the facilities will be dependent on the number and needs of employees to be served, extent of treatment and other activities included within the scope of the occupational health program, number of doctors and nurses required in accordance with Chapter VIII of DOE 5480.1A, provision for reasonably anticipated expansion, accessibility, safe distance from hazardous operations in event of disaster, and radioactive conditions to be encountered.

(1) Location.

The location of these facilities in an immediate plant area will be influenced by the following factors:

(a) Noise Level of Nearby Plant Components. The need for a quiet, restful environment shall be recognized.

(b) Accessibility. The main occupational health facility shall be easily accessible to the greatest number of employees, and clear of hazardous areas. Under certain conditions, a location near the main entrance to the plant to facilitate examination of employment applicants may be advantageous.

(c) Auxiliary Facilities. The use of dispensaries or first aid field stations serving as auxiliary medical units in outlying or hazardous areas may be necessary. These stations may occupy space in buildings provided primarily for other functions.

(2) Space Requirements. Space shall be provided to fulfill the current and reasonably foreseeable future requirements for the following functions:

(a) Physical examinations, including preplacement, periodic, and termination examinations.

(b) Diagnosis and pertinent treatment for immediate relief of injured and sick employees.

(c) Preventive care and counseling, immunizations, and health education.

4. ARCHITECTURAL. The review of final facility layout by the Headquarters' Office of Operational Safety is recommended to assure adequacy of equipment and arrangement, and other features indentified in this Chapter XXV.

a. Decontamination Areas. When required, emergency and decontamination facilities shall be planned so as to be entirely separated from routine service functions. However, the design of decontamination facilities shall permit their use for routine service until such time as an emergency occurs. One or more decontamination suites may be grouped to meet plant requirements. (See typical layout in Attachment XXV-1.) The

decontamination components, supplies, and equipment described below shall not be construed as adequate to provide for severely contaminated or injured personnel.

(1) Components. A decontamination suite should consist of the following components, arranged in the sequence shown:

(a) A separate entry or reception ramp, easily accessible by ambulance.

(b) A disrobing room with provisions for handling discarded contaminated clothing.

(c) A shower room with equipment for overhead or deluge showers and for prone treatment.

(d) An examining room or space.

(e) A clean room.

(f) Exit.

(g) A staff change room.

(2) Doors. Decontamination, treatment, restroom, and ward doors shall be of sufficient width to permit litter manipulation. All doors to decontamination suites shall be properly marked by emergency signs or by a system of lights to warn of contamination hazards.

(3) Supplies and Equipment. Sufficient supplies and equipment shall be available to administer emergency treatment without requiring contact with the rest of the building. Equipment shall include radiation monitoring instruments, shielded contaminated clothing receptacle(s), examining and treatment table, required laboratory equipment, and communications devices (e.g., intercom) with communications capability from inside the contaminated area to personnel in the outside clean area.

(4) Decontamination Features. Features shall be provided for ease of decontamination, such as the use of suitable washable or strippable paints or suitable metal liners on walls, ceilings, and floors. Care shall be taken to avoid exposed piping, ducting, cracks, and crevices.

b. Emergency Treatment Rooms. Easy access, without steps, will be necessary from the outside. The line of travel to examining and treatment rooms shall avoid the waiting room area. Small scrub-up and sterile supply rooms may be required. Ample electrical service and controls for special overhead lights, wall and floor service outlets, and sterilizing and special equipment shall be provided. Minor surgical rooms will need to be

justified on the basis of types of hazard, frequency of expected use, and distance to outside surgical facilities. If a minor surgical room is justified, the quantity and type of equipment shall be based on the types of surgery to be performed and the frequency of expected use.

c. Examining and Specialized Treatment Rooms. Room layout will depend largely upon the extent of the examinations and treatments, and the degree of privacy desired. Subsidiary waiting areas and dressing rooms or booths for the various clinical sections are appropriate where large laboratory, physical examination, sight, or hearing screening programs exist. It is generally desirable to provide two dressing rooms for each examining room to increase operational efficiency. Separate space for the testing of vision and care of eye conditions, and sound-proofed rooms or booths for audiometric testing shall normally be provided. Toilet facilities shall be located near the examination and treatment areas. Examining and treatment rooms shall be individual units operating from a corridor. If the requirements of a particular medical unit are such that more than one examining room is needed, the rooms shall be grouped, preferably back-to-back or side-to-side, to allow such utilities as water and waste services to be centralized.

d. X-Ray Facilities. X-ray facilities in medical units are highly desirable and should be provided, except in small health care units. Where the plant population is small (under 300), the availability of outside hospitals, offsite X-ray facilities and mobile units shall be investigated, and the relative cost and quality of this service and of onsite facilities shall be evaluated.

e. Laboratories. A normal laboratory shall include facilities for urinalysis, blood studies, and specific tests (such as bioassay, and bacteriological or biochemical tests) required by the program.

f. Physiotherapy Apparatus. The installation of physiotherapy equipment is usually justified. The type and number of devices will depend upon the nature of the facility.

g. Bedrest Rooms and Wards. In the majority of installations, wards should not be necessary. Beds for employees who become ill or faint after minor injuries or are convalescent shall be provided; with separate facilities for men and women.

h. Waiting Rooms. Usually a single main waiting room of adequate size will suffice. The design shall provide for an attractive appearance, pleasing color and harmonious furnishings within reasonable cost limitations. Applicants for employment, or others waiting for routine physical examinations may, if advantageous, be segregated from the patients. A waiting room in the personnel department (if adjacent) could be used for applicants awaiting preplacement and other routine physical examinations. It is highly desirable to have toilet facilities available near the waiting room.

i. Control Post. Regardless of the size of the medical unit, a control post shall be established to enable proper and constant supervision of all persons entering the facility. In a small unit, the control post may consist of a desk with files nearby. In a larger unit, it may consist of a booth or window or a small office where a reception nurse or clerk may obtain a history and have ready access to the record files. The control post shall be adjacent to the waiting room.

j. Filing Space. Except for relatively small units, a separate record room shall be provided (adjacent to the waiting room, if possible), to assure greater privacy and to safeguard the confidential nature of the health records. Standards of health and fitness can generally be better maintained by control of all examinations, rechecks, and other measures through centralization of medical records.

k. Office Space. Space assuring privacy shall be provided for the medical director; members of the medical staff; and, in larger installations, the nursing supervisor. In small installations, physical examinations may be performed in the physicians' offices, particularly if booths or screens for disrobing are provided. Two disrobing rooms connected with each doctor's office, insulated to assure privacy of conversations, will permit maximum use of physicians' time. Where physicians' offices are separate and not used for examinations, they shall be located near the examining and treatment rooms.

l. Dispensaries and First Aid Stations. These facilities, consisting of a first aid room and storage areas, are used to provide immediate relief for injured employees. They should be well lighted, thoroughly ventilated, and well heated. It is highly desirable to have toilet facilities available. The first aid room shall be supplied with hot and cold running water, proper drainage, and adequate telephone service for emergencies. A waiting room shall be provided where justified.

m. Interior Finishes. The character of the function will influence the selection of interior finishes and selection of color schemes. See paragraph 4a(4), above, for interior finish criteria applicable to contaminated areas. Particular care shall be taken to assure privacy of conversations between doctor and patient. Finishes shall generally be in accordance with the following:

(1) Floors. Finished floors shall be vinyl asbestos except in special areas. In such areas as laboratories and dark rooms, vinyl or vinyl asbestos and rubber of vinyl cove base may be used. Emergency rooms or surgical areas shall have vinyl, all purpose, static-proof, conductive flooring. Stairways, entries, and service and utility areas shall generally be concrete (cement cove base in janitor's closet). Corridor flooring may be concrete or vinyl asbestos with rubber or vinyl cove base. Toilet and washrooms shall have ceramic tile floor and base.

(2) Walls. The use of plaster shall generally be avoided except as may be required in contaminated areas to facilitate decontamination and in such areas as emergency, X-ray, dark, and treatment rooms. Painted finishes shall be used throughout the remainder of the facility, such as on masonry walls, dry wall, and factory finished prefab. Stairways and corridors may be protected with hardboard wainscot. Portland cement plaster or tile may be used for wainscots in built-in shower stalls. Where tile is to be used, structural facing units shall be considered. Proper radiation shielding shall be provided for X-ray and control rooms. The services of qualified persons in radiation shielding, particularly as related to x-ray shielding, shall be utilized for design.

(3) Ceilings. The use of plaster for ceilings shall be limited to those rooms where it is used as a wall finish. Acoustical treatment shall be used where functionally needed. Acoustical materials shall be noncombustible and should be applied directly to the ceiling unless other methods of installation are more economical, or where suspended ceiling is justified for sanitary or other reasons.

(4) Doors and Frames. Wood or combination steel buck and frame shall be used with wood flush doors. The use of sliding doors in medical units is not desirable because of difficulty in maintaining cleanliness. Doors shall be sized to permit passage of stretchers, where needed.

n. See Chapter IV for additional architectural design criteria.

5. MECHANICAL. The need for special plumbing fixture controls (arm, foot, or knee) shall be analyzed. All health facilities should be air-conditioned. Heating, ventilating, air-conditioning, and plumbing system design shall conform with the criteria contained in Chapter V. The ventilation system shall be designed to prevent the spread of contamination within and beyond the decontamination suite. Deluge showers and eye wash fountains shall be provided in the shower room. Other applicable mechanical systems' design criteria are contained in Chapter XVII.

a. Equipment. Occupational health facilities may be equipped as suggested by the Council on Occupational Health of the American Medical Association. Maximum use of portable equipment shall be considered in the planning and selection of special equipment. The services and utilities to be provided shall be based on a thorough study of equipment demands. Special gases and liquids, if required, shall be provided in portable cylinders and containers. Their location and other features shall be in accordance with the National Fire Protection Association (NFPA) National Fire Code requirements.

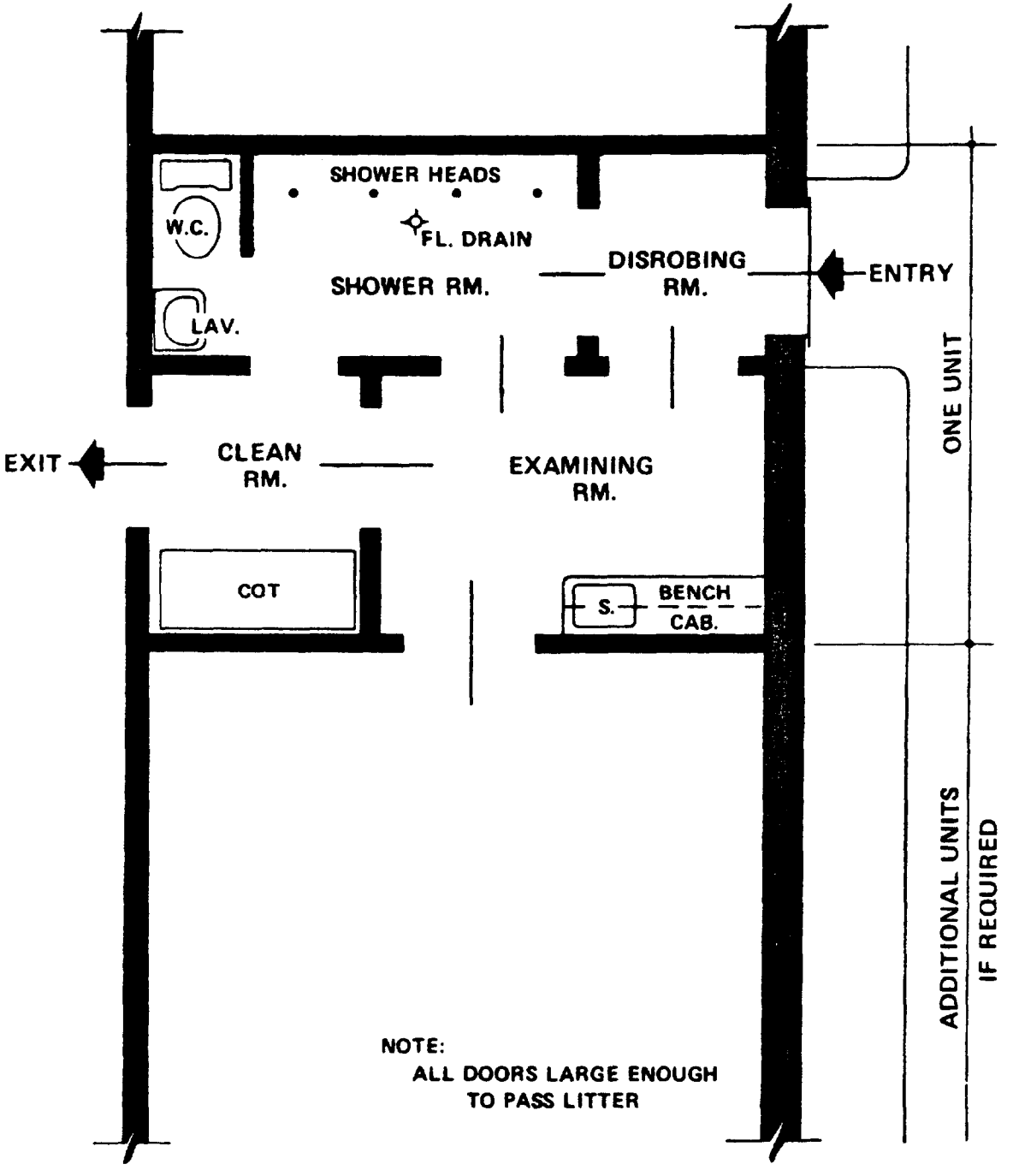
b. Waste Disposal. Radioactively contaminated liquid and solid wastes shall be separately collected, monitored, and disposed of. Contaminated liquid wastes shall not be discharged into sanitary sewers.

6. ELECTRICAL. Electrical design shall conform to the criteria contained in Article 517, "Health Care Facilities," and other requirements of the National Electrical Code; and Chapters VI and XVII of this Order.

7. FIRE PROTECTION. Chapter X contains the basic fire protection criteria to be followed.

8. ACCESSIBILITY AND USABILITY BY THE PHYSICALLY HANDICAPPED. See paragraph 13, Chapter IV of this Order.

## TYPICAL LAYOUT OF A CONTAMINATED CASUALTY AREA



# CHAPTER XXVI

## TELECOMMUNICATIONS, ALARM, AND AUTOMATIC DATA PROCESSING CENTERS

1. COVERAGE. These criteria, supplementing the basic design criteria in Chapters I through XV, shall be applied in the planning and design of telecommunications centers, fire and security alarm centers, automatic data processing (ADP) centers, and other special purpose communication centers, and related facilities. Particular use shall be made of the criteria in Chapter VII, "Interior Telecommunications and Alarm Systems," and Chapter IX, "Exterior Telecommunications and Alarm Systems," because of interface relationships to the design criteria in this Chapter. In addition, since telecommunications centers and other facilities will often utilize or share distribution wireways or radio frequency spectra with telecommunications channels or radio frequency communications systems covered by DOE 5300.1A, TELECOMMUNICATIONS, and other DOE directives in the 5300 series, use of those directives will also need to be made.

   a. These criteria cover the following types of telecommunications, alarm, and ADP centers and related facilities.

| Paragraph | Centers |
|---|---|
| 5 | Telephone Switching Centers |
| 6 | Teletype, Data, and Facsimile Centers |
| 7 | Computer/Automatic Data Processing Centers |
| 8 | Radio Control Centers |
| 9 | Fire Alarm Control Centers |
| 10 | Security Alarm Control Centers |
| 11 | Miscellaneous Special Purpose Communications Centers |
| | **Related Facilities** |
| 12 | Radio Repeater Stations |
| 13 | Antenna Towers, Poles, and Masts |

   b. These centers may occupy spaces within buildings or may be in separate buildings.

   c. There are many fundamental design criteria applicable, in whole or in part, to telecommunications, alarm, ADP and other centers, and to related radio repeater station facilities. These are contained in paragraph 4, below. Paragraphs 5 through 12, contain supplemental criteria for the specific centers and radio repeater stations.

   d. Security requirements for facilities that handle classified or sensitive unclassified information and materials may involve special design of the architectural, structural, mechanical, and electrical and communications features. The security requirements shall be determined as early as practicable in the facility planning or design phase and approved by the DOE security authority having jurisdiction.

e. The design requirements for a telecommunications center or radio repeater station that is designated as an asset of the National Communications System (NCS) shall be coordinated with the DOE Headquarters' Division of Telecommunications, Office of Computer Services and Telecommunications Management, to assure that technical standards applicable to the NCS are satisfied. Assistance in the planning and design of telecommunications centers and related facilities will also be supplied by the Office of Computer Services and Telecommunications Management on request.

f. These criteria do not cover the design of telecommunications, alarm, or ADP equipment or circuits; or the design of instrumentation or control centers used to monitor, measure, or control production or manufacturing processes, laboratory operations, or building services, except to the extent that such centers utilize telecommunication and alarm facilities described herein.

2. CODES, STANDARDS, GUIDES AND DOE DIRECTIVES. In addition to applicable codes, standards and guides identified in the basic design Chapters I through XV of this Order, the latest editions of those listed below, and the latest editions and changes to other DOE directives and Federal regulations that are listed below, shall also be followed.

a. WASH 1245-1, "Standard for Fire Protection of AEC Electronic Computer/ Data Processing Systems," of 7-73.

b. National Fire Protection Association (NFPA), "National Fire Codes."

c. National Electrical Safety Code, ANSI C-2.

d. National Electrical Code, ANSI/NFPA-70.

e. Office of Management and Budget (OMB), Circular A-71, as supplemented by Transmittal Memorandum No. 1, "Security of Federal Automated Information Systems of 7-27-78.

f. Title 41 of the Code of Federal Regulations (CFR), Chapter 101, "Federal Property Management Regulations:" Subpart 101-35.3, "Security of Federal ADP and Telecommunications," and Subpart 101-36.7, "Environmental and Physical Security."

g. Department of the Army Technical Manuals (TM) 11-486 Series, "Electrical Communications Systems - Engineering."

h. National Telecommunications and Information Administration (NTIA), "Manual of Regulations and Procedures for Federal Radio Frequency Management."

i. Electronics Industries Association (EIA) Standards.

j. American National Standards Institute (ANSI) Standards.

k. Federal Aviation Administration (FAA) Handbook OAP 7460.0, "Obstruction Marking and Lighting."

l. Title 14 of the Code of Federal Regulations (CFR), Part 77 (with regard to obstructions in navigable air space).

m. Federal Emergency Management Agency (FEMA), Technical Report TR-61, "EMP Threat & Protective Measures," of 4-80.

n. Department of Defense/Office of Civil Defense, Technical Report TR-61B, "EMP Protective Systems," of 11-71.

o. Defense Civil Preparedness Agency, Technical Report TR-61A, "EMP Protection for Emergency Operating Centers," of 7-72.

p. Department of Energy Directives:

(1) DOE 1360.1, ACQUISITION AND MANAGEMENT OF AUTOMATIC DATA PROCESSING EQUIPMENT AND RESOURCES, of 8-9-78.

(2) DOE 1360-2, COMPUTER SECURITY PROGRAM FOR UNCLASSIFIED COMPUTER SYSTEMS, of 3-9-79.

(3) DOE 5300.1A, TELECOMMUNICATIONS, of 11-16-81.

(4) DOE 5300.2A, TELECOMMUNICATIONS: EMISSION SECURITY (TEMPEST), of 8-30-82.

(5) DOE 5300.3A, TELECOMMUNICATIONS: COMMUNICATIONS SECURITY, of 12-7-83.

(6) DOE 5300.4, TELECOMMUNICATIONS: PROTECTED DISTRIBUTION SYSTEMS, of 10-28-81.

(7) DOE 5310.1A, TELECOMMUNICATIONS: DATA COMMUNICATIONS FACILITIES, SERVICES, AND EQUIPMENT, of 9-3-82.

(8) DOE 5320.1A, TELECOMMUNICATIONS: SPECTRUM DEPENDENT SERVICES, of 9-21-81.

(9) DOE 5330.1, TELECOMMUNICATIONS: TELEPHONE SERVICES, of 7-31-80.

(10) DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER, of 7-18-79.

(11) DOE 5636.2, SECURITY REQUIREMENTS FOR CLASSIFIED AUTOMATIC DATA PROCESSING SYSTEMS, of 1-10-80.

3. PLANNING AND LOCATION.

a. Telecommunications, alarm, and ADP centers should generally be located near the geographic center of the area served to provide maximum electrical range and communication coverage to:

(1) Reduce cable, ducts, and other outside distribution services;

(2) maximum security protection in appropriate facilities; and

(3) minimize system operating and maintenance costs.

b. Other than center area locations will be more advantageous in some cases due to;

(1) anticipated changes in the service area configuration;

(2) off-center pattern of load concentrations;

(3) required proximity to security forces, fire department, or other principal users;

(4) required antenna elevation for radio propagation purposes;

(5) height restrictions;

(6) avoidance of hazardous areas; and

(7) or minimizing leased circuit charges.

c. Centers and radio repeater stations shall be placed in fire-resistant noncombustible structures and should be located outside hazardous areas, including those subject to explosion, fire, flood, chemical fumes, excessive dust, vibration, dampness, and high acoustical or electrical noise levels. Suitable protection shall be provided where location in hazardous areas cannot be avoided.

d. The functional requirements of telecommunications, alarm, and ADP centers are subject to growth. In this regard, the minimum of a 5-year growth forecast shall be made, and these future requirements shall be carefully considered when locating and committing space for these facilities.

e. Radio repeater stations are usually unattended facilities, and located remote from service areas. The site shall be determined in accordance with applicable provisions of DOE 5320.1A, "TELECOMMUNICATIONS: SPECTRUM DEPENDENT SERVICES," and in coordination with the Headquarters' Office of Computer Services and Telecommunications Management.

f. The design of centers and radio repeater stations shall provide for fire protection and security in accordance with:

(1) Chapter X, of this Order;

(2) DOE 5632.1, PHYSICAL PROTECTION OF CLASSIFIED MATTER;

(3) DOE 5300.3, TELECOMMUNICATIONS: COMMUNICATIONS SECURITY;

(4) DOE 5300.2, TELECOMMUNICATIONS: EMISSION SECURITY (TEMPEST);

(5) DOE 5636.2, SECURITY REQUIREMENTS FOR CLASSIFIED AUTOMATIC DATA PROCESSING SYSTEMS; and

(6) DOE 1360.2, COMPUTER SECURITY PROGRAM FOR UNCLASSIFIED COMPUTER SYSTEMS.

g. Centers that process classified matter or information shall be located within secure areas. Where no classified matter or information is involved, centers need not be located in secure areas. As a minimum, they shall be located and arranged to assure effective personnel access control. Centers where sensitive unclassified matter or information is involved should be located within security areas, whenever feasible.

4. CRITERIA APPLICABLE TO ALL CENTERS AND REPEATER STATIONS. In paragraphs 5 through 12, below, supplementary criteria are provided for each particular type facility. The criteria in this paragraph 4 are to be followed in combination with the individual criteria for each type of facility. Where the individual facilities' criteria are more stringent than comparative criteria in this paragraph 4, the individual facilities' criteria shall govern.

a. Layout. The configuration of equipment, operating, storage, maintenance, and utility areas and the layout of these areas shall be so designed as to:

(1) Permit optimum functioning of operating and maintenance personnel.

(2) Provide adequate access to equipment and physical clearances between items of equipment. Aisle space between equipment mounted in racks or cabinets and between the equipment and adjacent walls should not be less than 3 ft. Additional working space may be required for equipment which involves hazardous voltage, such as microwave transmitters.

(3) To permit locating related equipment and operating areas together and to assure that the associated storage and maintenance areas are readily accessible. Storage and maintenance areas shall usually be separated from equipment and operating areas by suitable fire-resistant walls or partitions.

(4) Provide the necessary physical and technical security measures.

(5) Provide the necessary basic structural, architectural, environmental, mechanical, and electrical features and systems that will be compatible with future expansion needs, based upon estimated 5-year growth requirements. Telecommunications, alarm, and ADP equipment and their operations are particularly sensitive to the dust, vibration, dampness, fumes, noise, and electrical interference normally created during remodeling work. To the extent practicable, therefore, and to minimize the ultimate facility costs, the estimated requirements for future needed wall and floor penetrations, utility extensions, and so forth should be satisfied in the initial facility by providing spare construction features such as doorways, cable slots, sleeves conduit and piping stubs (equipped with removable covers, caps, or panels).

b. Architectural. The basic criteria to be applied in architectural design are contained in Chapter IV of this Order. Also see paragraph 3, in Chapter I for additional criteria.

(1) To facilitate installation and replacement of equipment, centers should be located at grade level. Otherwise, adequate ramps or elevators shall be provided. Entryways and corridors leading to equipment rooms shall be adequately sized and arranged to facilitate installation and replacement of equipment. If possible, direct access from the outside should be provided to the principal equipment areas for equipment installation and replacement, particularly where the items of equipment are large. Such access doors shall be sized commensurate with known and anticipated equipment requirements. These access door dimensions should not be less than 5 ft. wide and 7 ft. high. Exterior access doors shall be weather-tight and normally secured from within the center. If necessary, a loading dock or ramp and an all-weather driveway may be provided to facilitate equipment movement into and out of the center. If outside personnel entrances to principal equipment areas are provided for use by maintenance technicians, adequate protection shall be provided to minimize the intrusion of dust and moisture.

(2) Operating and equipment areas that contain relays, switches, electronic devices, and other dust-sensitive equipment shall be designed to be relatively dust-free. To minimize the intrusion of dirt and dust from outside the centers and into these operating and equipment areas, these areas should be windowless. All exterior doors shall be weather-stripped. Access to the equipment and operating areas should be through vestibules, foyers, corridors, or other buffer areas. Interior concrete and masonry surfaces shall be smoothed and sealed, floors shall be tiled, and other surfaces should be painted or otherwise finished to facilitate cleaning.

(3) Basement space should not be used to house telecommunications equipment unless adequate protection is provided to prevent damage from flooding or other moisture and water hazards.

(4) Personnel entrances to the centers shall be so arranged as to permit effective control of access to the operating and equipment areas. Administrative areas should be strategically located with respect to personnel entrances and to the operating areas so that visitors to these areas do not pass through the equipment or operating areas or otherwise distract operating or maintenance personnel. Where practicable, provide the supervisor's office with an unobstructed view of the communication center operations.

(5) Operating areas shall be located and constructed to minimize outside noise interference and acoustically treated to maintain a low internal sound level commensurate with the operating requirements.

(6) Where commercial meal service is not available to operating personnel or where the nature of operations is such as to prevent the utilization of the normal services, lunchroom and food preparation facilities should be provided within the center. Lockers and lounge areas may be provided for operating personnel, as required.

(7) Centers that are frequently attended by only a single operator shall have restroom facilities directly accessible from the operating area.

(8) Centers such as telephone teletype, data, facsimile, ADP, radio and fire alarm control, and other such occupied facilities can generally have opportunities for employment of physically handicapped persons. Wherever such opportunities exist, suitable provisions shall be made. See paragraph 13 in Chapter IV of this Order.

c. Structural. The basic criteria to be applied in structural design are contained in Chapter IV. Also see paragraph 3 in Chapter I for additional criteria.

(1) The weight of equipment and support facilities is often of sufficient magnitude that the initial and estimated future equipment layout and associated structural requirements will necessitate careful coordination. In some areas, the weight of equipment mounted in racks or cabinets, storage batteries, and cable distribution systems can impose concentrated floor loads on the order of 350 pounds per square foot or greater. Expansion of these facilities can impose greater concentrated floor loads as well as greater average floor loadings. The structural design shall be based upon the ultimate equipment (and support facilities) layout with proper allowance for additionally imposed loads during equipment installation.

(2) The placement of columns and beams should be avoided in equipment and operating areas. Otherwise, their location shall be coordinated with the initial and estimated future equipment installations, utility services, and operating requirements. Avoidance of internal columns in telecommunications, alarm, and ADP centers is particularly important in areas which will require shielded enclosures.

(3) Roof hatches or emergency access doors or panels can be required for firefighting or other emergency access in windowless buildings or spaces.

(4) Telecommunications centers and radio repeater stations which involve roof-mounted antennas and/or towers will usually require special roof framing.

(5) Telecommunications facilities which are to be protected against the effects of nuclear weapons shall be installed in structures designed to withstand these effects. The space, utility requirements and equipment layout shall be in accordance with the criteria in

paragraphs 4a and 4b, above, and with advice and guidance obtained from the Headquarters' Office of Computer Services and Telecommunications Management.

(a) Shielding against the electromagnetic effects or the electrostatic effects of nuclear weapons shall be provided, as required, for those facilities that are located in structures specifically designed to withstand 5 psi or greater overpressure effects of nuclear weapons. Protective measures shall generally be in accordance with the concepts contained in Defense Civil Preparedness Agency publication TR-61A, "EMP Protection for Emergency Operating Centers," of 7-72; Department of Defense/Office of Civil Defense publication TR-61B,"EMP Protective Systems," of 11-71; or later developed concepts by the Federal Emergency Management Agency (FEMA). Also see FEMA publication TR-61B, "EMP Threat & Protective Measures," of 4-80, for additional information.

(b) Flexible conduit connections for communications cables serving hardened centers shall incorporate sufficient slack to withstand the anticipated displacement conditions but shall not impair the installation or replacement of cables. Within the centers, floor inserts shall be provided to secure the equipment to the floor through shock mounts designed to withstand the anticipated blast effects. Ceiling inserts shall be provided to brace equipment racks and cabinets and to support overhead cable racks or trays.

(c) Where radio communications or control equipment requires one or more exposed antennas having no significant blast resistance, provisions shall be made to replace the antennas from within the shelter. Normally retracted "pop-up" antennas, operable from within the hardened area, shall be provided.

d. Mechanical. The basic criteria to be applied in the design of mechanical systems are contained in Chapter V.

(1) Unless other requirements are established by the telecommunications equipment and materials manufacturers and/or otherwise justified for operating personnel comfort, inside design temperatures shall be in accordance with paragraph 7c in Chapter V. Special attention shall be given to relative humidity control for operating and equipment areas to satisfy requirements specified by the equipment manufacturers, e.g., in automatic data processing (ADP) centers. Criteria for environmental control within radio repeater stations are contained in paragraph 12e, below.

(2) Consideration shall be given to utilization of the heat produced in certain types of equipment (such as rectifier-charger bays, radio and microwave transmitters, ADP equipment, etc.) to minimize the

overall facility requirements in the heating season; and to directly exhausting (or otherwise transferring) this heat gain during the cooling season to minimize the air-conditioning requirements.

(3) Ventilation of storage battery areas shall comply with appropriate provisions of the National Fire Codes and the National Electrical Safety Code. Where it is planned to locate storage batteries in the same room with telecommunications or alarm equipment, in lieu of providing a separate (and separately ventilated) battery room, careful consideration shall be given to the adequacy of the normal room ventilation system and possible need for supplemental or emergency backup ventilation capability. Particular attention shall be given to conditions during scheduled or emergency shutdown of the normal room ventilation system.

(4) For operating and equipment areas that contain dust-sensitive equipment, the ventilation system should normally be designed to maintain a positive pressure within these areas. The necessary mechanical filters, listed by Underwriters Laboratories Inc., shall be provided in all air intakes, commensurate with the dust control requirements. In addition, electrostatic precipitators may be used to achieve a greater degree of dust control, if required.

e. Electrical. The basic criteria to be applied in the design of interior electrical systems are contained in Chapter VI.

(1) Telecommunications, alarm, and ADP centers will usually require several raceway systems in addition to those required in providing lighting, environment control, and general purpose convenience outlets. The raceway requirements, described below, shall be determined for each center early in the planning stage and applied in its layout, structural framing, floor construction, and other design features. Separate raceways should usually be provided for:

(a) Electric power conductors serving specific equipment.

(b) Conductors installed by communications carriers to provide leased telephone, teletype, and related telecommunications services.

(c) "Room circuits" interconnecting proprietary (noncarrier) equipment within the center.

(d) Proprietary conductors interconnecting fire alarm, security alarm, and watchman reporting devices located outside the center with central station supervisory and alarm equipment.

(e) Radio frequency (RF) transmission lines between radio transmitters, radio receivers, and antennas.

(2) The design of electric power and lighting systems shall be coordinated with the equipment (system) engineers and security personnel to assure the provision of adequate circuit and equipment separations and circuit capacities; and suitable positioning of power risers, power outlets, lighting fixtures, line filters, and controls.

(3) Where required to assure continuity of service to critical equipment items, not permanently connected to power sources, cord plugs and outlets shall incorporate a "twist-lock" type feature. Unless otherwise required, all single-phase electric power outlets within the centers shall be served by three-wire circuits, terminating in polarized and grounded duplex receptacles and carrying an equipment ground as well as a system ground.

(4) The types of lighting fixtures selected, their location, and the illumination levels shall be carefully coordinated with the equipment and operating functions of telecommunications, alarm, and ADP centers, to provide the required illumination without:

(a) Interfering with prompt identification of illuminated signals.

(b) Creating reflecting glare which might detract from adequate observation of essential equipment functions.

(c) Creating electrical interference detrimental to proper operation of radio-receiving or other sensitive equipment.

(5) Where continuity of power supply is essential, it should be provided from at least two separate sources, e.g., from separate incoming services supplied from different generating sources or major substation facilities, or from the incoming service and a standby power generator source.

(6) The normal incoming power service shall be sized to supply the anticipated peak requirements of the facility, based upon a 5-year growth forecast. Where a center occupies space in an office, laboratory, or other building, the normal power service to the center should be supplied through a separate disconnect/protective device located ahead (on the line-side) of any power disconnect/protective device for the other portions of the building.

(7) The emergency power source, either a separate incoming power service, a standby generator unit, or an uninterruptible power system (UPS), shall be capable of satisfying the alternating current (AC) voltage stability and AC frequency stability requirement of the equipment being served.

(8) The emergency source shall be sized at a minimum to satisfy the peak power demand of the electronic and switching equipment during normal busy periods and all essential lighting, heating, ventilating,

air-conditioning, and other essential support equipment. In providing this emergency source, proper consideration shall be given to anticipated load increases based upon a 5-year growth forecast.

(a) Where the emergency power source is provided by means of a separate incoming commercial service (or a separate incoming service supplied from a central auxiliary power source), switching facilities shall be provided to automatically transfer the connected load to the emergency supply upon loss of the normal supply.

(b) Where emergency power is provided by means of a standby generator plant, facilities shall be provided to automatically accomplish starting and load transfer, upon loss of the normal supply. Where internal combustion prime movers are used, diesel engines are preferable to gasoline engines to reduce fire hazards. See Chapter VI for additional criteria.

(9) For application of UPS, see criteria in Chapter VI.

(10) Constant-voltage transformers may be provided, as necessary to meet the voltage stability requirements of the equipment.

(11) Consideration shall be given to the use of battery-operated emergency lighting units which operate automatically on loss of normal AC power.

f. Fire Protection.

(1) Chapter X contains the basic fire protection criteria to be applied. Fire protection requirements applicable to telecommunications centers and to radio repeater stations may involve special design features. The requirements applicable to each facility shall be determined as early as practicable during facility planning or design and approved by the DOE fire protection authority having jurisdiction.

(2) Noncombustible or fire-resistant construction shall be used with specific attention given to areas or compartments used for storage of significant amounts of paper, stock, forms, cards, tapes, and other combustible material. Emergency engine-generators shall be isolated from operating and equipment areas and located in a fire-resistant room or building annex. Associated fuel tanks should be buried outside. If above ground, they shall be located away from buildings and protected in accordance with applicable fire codes.

(3) Automatic fire detection systems capable of sensing excessive heat, smoke, or other products of combustion shall normally be provided in all centers, and particularly those that may be left unattended. Each system shall provide for automatic alarm transmission to local sounding devices and to the cognizant fire alarm center.

(4) Automatic sprinkler systems shall be provided in all centers except where the use of other automatic fire suppression systems or other methods for fire protection are specifically approved by the DOE fire protection authority having jurisdiction, based on the safety analysis for the particular center.

(a) The choice of the fire protection system(s) should be left to the judgment of competent fire protection engineers and should be dependent on an evaluation of all factors affecting the risk. Sprinkler system water control valves shall be electrically supervised and water flow alarms provided locally and at the fire alarm control center. The need for electrical supervision of post indicator valves (PIV) in open locations and accessible to the public shall be given careful consideration in the design of the fire protection system.

(b) Where automatic sprinkler systems are provided in areas to be occupied by telephone switching centers (or other vital centers housing equiment especially subject to water damage) and where the risk dictates the need, they shall normally be of the pre-action or multicycle type. The water valve shall be located outside the areas to be protected and shall be capable of automatic and manual operation. The controls feature shall normally be guarded to prevent unintentional operation. The automatic heat responsive system with more sensitive heat-sensing characteristics than the automatic sprinkler heads shall be installed in the area to be protected and shall perform the following functions:

1 Upon sensing excessive heat, smoke, or other products of combustion, opens the water valve, permitting water to flow into the sprinkler system and to discharge from temperature-actuated sprinkler heads which may be open.

2 Initiates alarms to the building alarm system and to the local fire alarm control center and shuts off electric power supply in those areas where fire may operate sprinkler heads before manual power shutdown could be accomplished.

3 Automatically closes the water valve after the emergency condition has been corrected (on multicycle systems only).

4 Shuts down the air circulation system, turns on exhaust fans, and opens smoke vents.

(c) All sprinkler systems shall be properly sized and designed based upon hydraulic calculations of water density requirements and water supply availability.

(5) Automatic means for deenergizing the electric power supply to the center and for shutting down the ventilating systems associated with the center may be required upon activation of the fire detection or fire extinguishing system. If automatic deenergizing means are used, appropriate manual reset shall be provided.

(6) All centers shall be equipped with UL listed portable fire extinguishers to provide for Class A type fire control (wood, paper, cloth, rubbish) and for Class C (electrical), as required. Listed Class A fire extinguishers that are provided for protection of computer rooms and equipment shall be of the plain water type, only, in accordance with NFPA 75 requirements.

5. TELEPHONE SWITCHING CENTERS. These centers provide administrative and operational private branch exchanges (PBX) services. The criteria contained herein apply primarily to those centers that contain switching equipment and attendant switchboards or consoles, and they are applicable, in part, to centers that contain only manual switchboards or unattended switching equipment. It is assumed that the PBX equipment will be rented from an operating common carrier (telephone company). Emphasis is placed upon the need for close coordination with the telephone company, beginning early in the planning stages and continuing throughout the design stages. These criteria are also adaptable to centers containing Government-owned equipment.

a. Location.

(1) The location, size, and general configuration of each center shall be determined early in the planning stage and shall be based in part upon:

(a) The site development plan (master plan);

(b) The initial and ultimate service requirements in accordance with DOE 5330.1, TELECOMMUNICATIONS: TELEPHONE SERVICES;

(c) The recommendations of the telephone company; and

(d) Advice from DOE and operating contractor user groups.

(2) Wherever practicable, and to minimize recurring operating costs, telephone switching centers shall be located within the building which is expected to incorporate the major requirements for telephone station circuits, or in an interconnecting structure.

(3) Preliminary site plans shall be prepared and furnished to the telephone company for their review and recommendations. These plans should indicate the proposed location of the center, existing and proposed structures, utility lines, roads, walkways, suggested routing for telephone trunk lines and distribution plant, vault and manhole locations, and other applicable site features. See Chapter IX for factors to be considered in the design of pole lines, trenches and duct systems.

b. Layout.

(1) Preliminary building plans shall be prepared and furnished to the telephone company for their review and recommendations. These plans should indicate types of construction, spaces allocated for telephone company equipment and their approximate dimensions, tentative locations of utility service entrances, mechanical equipment areas, corridors, stairways, and so forth. In telephone equipment areas, the proposed size and location of all openings, columns, beams, and ceiling heights shall be shown. Ventilating ducts, utility services, and other service or structural features which must be accommodated in the telephone equipment areas shall also be shown.

(2) The initial and ultimate requirements for telephone stations, leased lines, and other telephone company services shall be determined for each area of the switching center and, where applicable, for the building in which it will be located or to which it will be connected. This information shall be furnished to the telephone company for use in planning its house cable and station wiring layout. See Chapter VII for telephone facilities design criteria.

(3) Drawings and other information shall clearly define those facilities and services which are to be furnished and installed by the Government and those which will be furnished and installed by the telephone company. The requirements, recommendations, and proposed dates for telephone equipment installations furnished by the telephone company shall be reviewed by the architect-engineer and clarified with the telephone company.

(4) Questions and problems regarding design of the center shall be resolved or referred to the DOE and DOE operating contractor user groups for decision during the planning of switching centers. Similar coordination shall be effected during the design phase and in the processing of subsequent changes in the design or construction of the center.

(5) Centers shall be sized and utility systems provided to accommodate all equipment and related installation, operation, and maintenance activities necessary to meet the anticipated telephone service requirements within 5 years after start of service.

c. Architectural-Structural.

(1) The switching equipment room and the attendant switchboard or console room shall be oriented to facilitate expansion of the cable distribution frame and switchboard positions in the alignment recommended by the telephone company for most efficient operation and maintenance.

(2) Adequate space shall be provided for the telephone company's test equipment, maintenance records, parts storage, tools, and work areas.

(3) Vaults shall be readily accessible from within the center; adequately lighted, ventilated, and drained; and arranged to permit installation of cable-pressurizing facilities. Advantages of locating the cable vault adjacent to and at the level of the main distributing frame should be given consideration.

d. Mechanical.

(1) Where switchboard or console operators are seated higher than other employees within the room, special attention shall be given to minimizing temperature imbalances between the working levels, for employee comfort. This may be accomplished with the use of insulated floors (or carpeting), baseboard room heating, or other means. Carpeting also has the advantage of reducing room noise levels.

(2) Wherever practicable, power control boards, rectifiers, storage batteries, battery chargers, ringing machines, tone generators, etc., shall be located in rooms separate from the switching equipment and equipped to exhaust the ventilating air directly to the outside. Design of the power equipment rooms and ventilation systems should be such that a positive internal air pressure can be maintained in the equipment area.

e. Electrical.

(1) Sufficient cable rack channels or inserts, pulling-in irons, and ground busses shall be provided in cable vaults to meet the foreseeable requirements.

(2) Cable ducts, conduits, and sleeves shall be equipped with rust-resistant pull wires. Vaults that are directly accessible from outside the switching center shall be equipped to permit locking of the door or manhole cover from inside the vault.

f. Fire Protection. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

6. TELETYPE, DATA, AND FACSIMILE CENTERS. These centers provide administrative and operational teletype, data, or facsimile services, where messages are transmitted and received in clear text or in encrypted form. These criteria primarily apply to secure communications centers (those incorporating all security safeguards applicable to cryptocenters where all messages are encrypted or decrypted). They are also applicable, in part, to communications centers that also, or only, contain data and/or facsimile communications equipment, to centers that do not contain cryptographic equipment, and to centers that contain separate and well defined areas for clear-text operations

and for cryptographic operations. See DOE 5310.1, TELECOMMUNICATIONS: DATA COMMUNICATIONS FACILITIES, SERVICES, AND EQUIPMENT, for criteria applicable to teletype, data, and facsimile services and for cryptographic services. Each new center shall be designed in accordance with the criteria described herein for secure communications centers unless specific authority is obtained from the DOE security authority having jurisdiction to exclude those design features that are applicable to cryptographic operations. The exceptions may be those centers that will process only unclassified messages or those which will provide noncryptographic secure communications by means of protected distribution systems.

a. Location. To the extent practicable, teletype data, and facsimile services required for normal administrative and operational purposes at each DOE and DOE operating contractor installation shall be provided from a single secure center located in close proximity to the principal users. The location and planning for each center, including those centers that will process only unclassified messages or which will provide noncryptographic secure communications, shall be coordinated with the cognizant DOE security office and the user groups.

b. Layout.

(1) Depending on size, communications centers may contain the following:

(a) Teletypewriter transmitting, receiving and tape perforating equipment;

(b) Data and/or facsimile communications and cryptographic equipment;

(c) Cryptographic equipment for on-line operation and one or more off-line backup systems;

(d) Vaults, of vault type rooms or security filing cabinets for classified COMSEC (communications security) materials and messages;

(e) Storage containers for unclassified messages, COMSEC materials, operating supplies and message processing work areas;

(f) Collating, binding and photo processing facilities, and

(g) Equipment maintenance facilities.

(2) The ultimate configuration of operating, storage, and maintenance areas, initial and ultimate space and utility requirements and arrangements for effective control of access shall be determined in accordance with applicable provisions of DOE 5310.1, and advice and guidance from the Headquarters' Office of Computer Services and Telecommunications Management.

c. Architectural--Structural.

(1) Windowless space (for environmental and security reasons), column-free operating areas, and clear ceiling heights of not less than 8 ft., are essential if the center will be shielded (electromagnetic shielding).

(2) Acoustic treatment of the ceiling and upper walls down to wainscot level will normally be required to maintain acceptable internal sound levels.

(3) Normal floor loadings will usually be encountered. Where punched-card facilities are provided, concentrated loads can be on the order of 350 pounds per square foot or greater.

(4) Vault-type, or GSA approved combination lock doors shall be provided where security requirements dictate the need.

d. Mechanical. The heat gain and anticipated duty cycle of the equipment and any particular requirements for temperature, humidity and dust control shall be carefully determined. Design of the environmental control systems shall satisfy these requirements, taking into account the planned expansion of the facility.

e. Electrical.

(1) Design of the electrical and communications systems shall take into account the needs for special power and communication circuit filtering or other security measures.

(2) Cellular-type floor duct systems are preferred to permit flexibility in equipment layout and to provide the necessary separation between power and signal circuits.

(3) Intrusion detection and alarm systems shall be provided in accordance with the requirements established by the DOE security authority having jurisdiction.

(4) Electric strike and cypher door locks shall be provided where security requirements dictate the need.

f. Fire Protection. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

7. COMPUTER/AUTOMATIC DATA PROCESSING (ADP) CENTERS. These centers provide services to receive machine-readable data and/or prepare such data from source documents; collate, store, and process data; and produce information output as machine-readable data or clear-text printed material.

a. Location.

(1) Automatic data processing centers should be located in close proximity to the offices of the principal users and be readily accessible to related communications facilities.

(2) Centers which process classified data shall be established as, or located within, secure areas. Centers where it can be assured that only unclassified information will be processed will generally not need to be established as, or located within, secure areas. But, as a minimum, they shall be located and arranged to assure effective personnel access control. Centers where sensitive unclassified information will be processed should be established as, or located within, secure areas whenever feasible.

(3) Because of the high dollar value of equipment and the operating continuity requirements, particular attention shall be given to the location of ADP centers within multi-use buildings. Care shall be taken not to locate ADP centers in close proximity to, above, or below cafeterias, as grease or grease fumes from food preparation could adversely affect equipment operation. These centers should also not be located in close proximity to, above, or below photographic processing areas, chemical laboratory areas, or similar areas, as leaking chemicals and chemical fumes could also adversely affect equipment operation. The centers should also not be located adjacent to, or above, or below public areas or other uncontrolled areas, as damage to the ceiling, floor, or walls (from uncontrolled activities) could cause significant damage to the center and potential interruption of critical ADP operations.

b. Planning and Layout.

(1) Automatic data processing centers usually contain one or more of the following:

(a) Computers;

(b) Card punching, reading and collating equipment;

(c) Paper and magnetic tape equipment;

(d) Magnetic or disc storage units;

(e) High-speed printing, collating and binding equipment;

(f) Equipment for electrically exchanging data with other locations; and

(g) Related work areas.

(2) The optimum layout, initial and ultimate space and utility needs shall be determined in accordance with technical and physical security requirements, with recommendations of the equipment manufacturer or vendor, and with operating and maintenance requirements. (See DOE 5636.2, SECURITY REQUIREMENTS FOR CLASSIFIED AUTOMATIC DATA PROCESSING SYSTEMS; DOE 5300.3A, TELECOMMUNICATIONS: COMMUNICATIONS SECURITY; DOE 5310.1A, TELECOMMUNICATIONS: DATA COMMUNICATIONS FACILITIES, SERVICES, AND EQUIPMENT; DOE 5300.2, TELECOMMUNICATIONS: EMISSION SECURITY (TEMPEST)and DOE 1360.2, COMPUTER SECURITY PROGRAM FOR UNCLASSIFIED COMPUTER SYSTEMS.)

(3) Appropriate requirements of OMB Circular A-71, as supplemented by Transmittal Memorandum No. 1, "Security of Federal Automated Information Systems of 7-27-78;" Federal Property Management Regulations (FPMR) 41 CFR Subpart 101-35.3, "Security of Federal ADP and Telecommunications;" and FPMR Subpart 101-36.7, "Environmental and Physical Security," shall be satisfied in the planning and design of ADP centers.

(4) Operating activities (computing, data conversion, electric machine accounting, and data transmission) should be located together in the same or adjoining rooms. Supporting activities (storage, maintenance, power, and environmental control, scheduling, and administrative offices) should be housed in separate rooms adjacent to the central operations area. Storage areas for combustible material shall be physically isolated by fire resistant walls from equipment areas and provided with adequate fire extinguishing means.

(5) Provisions should be made for preservation of duplicate vital and important records, and backup data stored on discs, tapes, or other media, by storage in one or more separate vault or other approved storage facility locations; where such locations are not subject to a fire (or other disaster) or its associated effects that may involve the original records and other data in the ADP center. In most cases, separate vault or other approved storage facilities in another building(s) on the site, sufficiently distant from the ADP center, will be the best method from both safety and security standpoints. In other cases, a building(s) offsite may be the preferred method. See NFPA 75, Chapter 6, "Protection of Records," for Class I (vital) and Class II (important) records' duplication and storage requirements; and NFPA 232, "Standard for the Protection of Records," for fire resistance requirements for vaults, file rooms, and record protection devices.

c. Architectural--Structural.

(1) All areas of an ADP center shall be designed and finished to facilitate cleaning and provide an environment essentially free from dust, as described in paragraphs 4b and 4d, above. Vinyl floor tile shall be provided in areas subject to cleaners and lubricants used in

equipment operations, servicing, and maintenance. Acoustic treatment of the ceilings (and walls if necessary) in operating areas is desirable to maintain acceptable internal sound levels.

(2) Concentrated loads can be on the order of 350 pounds per square foot, or greater, in operating areas. Particular attention shall be given the requirements for floor or raised floor wireways, equipment cooling ducts, and piping in the design of the floor to minimize shock and vibration of computers and other ADP equipment. Only approved noncombustible floor systems shall be installed in centers where raised floors are to be provided.

(3) Shielding may be required to protect magnetic recording equipment, magnetic tapes, and disc packs where electromagnetic fields of 10 microvolts per meter or 50 oersteds or greater can be expected to exist within the center.

(4) Walls around secure ADP centers shall be constructed of concrete block or other suitable materials, and not plaster board or other materials that are easily penetrated.

d. Mechanical. The heat gain and anticipated duty cycle of the equipment and the particular requirements for temperature, humidity, and dust control shall be carefully determined and the design of the environmental control systems shall satisfy these requirements, taking the planned expansion of the facility into account. Air-conditioning, heating, and ventilating systems shall be designed to prevent cooled or heated air from discharging directly on the computer/ADP equipment.

e. Electrical.

(1) Design of the normal and emergency electrical power supplies shall be in accordance with paragraph 4e, above.

(2) Some portions of the ADP equipment and the functions performed may require greater-than-normal quality and reliability of electrical power supply. Where this will require an uninterrupted supply of electrical power, an uninterruptible power supply may be provided in accordance with paragraph 4e, above.

(3) Diffused lighting is preferred in operating areas, and spot lighting should be avoided to minimize temperature differentials in electronic equipment.

(4) Emergency shutdown of power for ADP facilities shall be provided in accordance with NFPA 75, "Standard for the Protection of Electronic Computer/ADP Processing Equipment."

(5) Electric strike and cypher door locks shall be provided for areas such as the computer room, and storage vaults/rooms where classified or sensitive unclassified data storage on disks, tapes, or other media is to be stored, where security requirements dictate the need.

f. Fire Protection. Automatic fire suppression systems and portable fire extinguishers shall be provided in accordance with the requirements in NFPA 75 and the criteria in paragraph 4f, above. Also see WASH 1245-1, "Standard for Fire Protection of AEC Electronic Computer/Data Processing Systems," for additional criteria.

8. RADIO CONTROL CENTERS. These centers provide equipment for operational control of radio communications systems. The following criteria primarily apply to centers containing local transmitting and receiving equipment and separately mounted control (console) equipment. They are also applicable, in part, to centers containing only the radio remote control equipment (for remote-located base station transmitting and receiving equipment) and to centers with only base station consolettes.

a. Location.

(1) Required elevations, land areas, and physical clearances required for radio antennas and their supporting structures shall be properly considered in determining the location of each radio communications control center.

(2) In locating a control center that contains radio receiving equipment, the avoidance of areas subject to high electrical noise levels is particularly important.

b. Layout.

(1) The initial and ultimate space and utility requirements shall be determined in accordance with applicable requirements of DOE 5320.1A, TELECOMMUNICATIONS: SPECTRUM DEPENDENT SERVICES, and advice and guidance from the Headquarters Office of Computer Services and Telecommunications Management.

(2) Transmitters and receivers may be located in the same room with the control equipment or in separate areas. The transmitters and receivers should be located as close as possible to their antennas and, where practicable, under the surveillance and access control of the console equipment operator.

(3) Provision should be made for installation of map boards, network charts, station call signs, station authorizations, and other materials required to be displayed; and located within easy view of the control equipment operator.

c. Architectural--Structural.

(1) In centers which are essential to DOE or DOE operating contractor functions, exterior walls should be windowless.

(2) Concentrated floor loads can be on the order of 350 pounds per square foot, or greater, in equipment areas. Requirements for microwave waveguide and radio frequency (RF) transmission line supports; ceiling, wall, or floor penetrations; special heat exhaust ducts; floor cable trenches; and channels and inserts for cable racks and equipment supports shall be carefully determined, taking any projected expansion of the facility into account.

d. Mechanical.

(1) Utilization of heat gain from the equipment, to satisfy or supplement space heating requirements during the heating season, and direct exhausting of heat gain during the cooling season shall be given proper consideration.

(2) Air-conditioning and ventilating registers should be so located that drafts on console and radio equipment are minimized.

e. Electrical.

(1) In determining the normal and emergency power supply requirements, it should be assumed that all transmitters may be keyed simultaneously for operational or maintenance purposes, while associated receivers and other equipment and building services are in operation. Design of the emergency power supply shall be in accordance with paragraph 4e, above.

(2) It may be necessary that certain power and lighting equipment be provided with radio interference filters, effective in the frequency range of the transmitting and receiving equipment.

(3) Cable trenches or floor ducts and risers should be provided for power and control circuits, where feasible. Otherwise, overhead cable racks may be used.

(4) Power conductors shall not occupy the cable trench or racks assigned for radio control and interconnecting cables, and telephone cables, where it is feasible to provide separate wireways.

(5) Where the control console is remote from transmitting and receiving equipment, telephone conduit shall be provided for voice communication circuits between these areas to facilitate maintenance and testing.

(6) Wireways shall be provided for the radio frequency (RF) transmission lines between each transmitter, receiver, or transceiver and its antenna(s). These RF lines require code separation from audio, control, and power conductors.

(7) Where "open-wire," rigid coaxial, or waveguide transmission lines are used, inserts or channels shall be carefully coordinated with support fittings, structural openings, and panels which meet the mechanical and electrical requirements of the lines and their usage.

(8) Where flexible coaxial cables are used for RF transmission lines, open cable racks or trays will provide the optimum cable capacity and flexibility of arrangement. Wireway design shall be compatible with the minimum bending radius requirement for the cables to be contained.

(9) At the point of building entry, waveguides and the outer sheath of each coaxial cable shall be effectively grounded via an electrically conductive bulkhead panel to two or more grounds outside the building line. A #4 AWG or larger copper ground conductor shall be extended from the bulkhead panel to metal cable racks or trays and to grounding devices at transmitters and receivers and at the control console. All power, signal, transmission line, and antenna structure grounds shall be effectively bonded together, unless separate grounding is required.

f. Fire Protection. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

9. FIRE ALARM CONTROL CENTERS. These centers provide central station monitoring of manual and automatic fire reporting devices and supervision of the condition of related fire detection and extinguishing systems and shall be designed in accordance with NFPA 71, "Central Station Protective Signaling Systems," and NFPA 72D, "Proprietary Protective Signaling Systems."

a. Location. The center should be located at the fire station which will respond to the incoming alarm and supervisory signals, except where the center may serve as a concentrator and relay station for several areas of protection.

b. Layout.

(1) These centers usually contain the following:

(a) Monitoring, recording and communicating alarm signals;

(b) Supervising and controlling circuitry;

(c) Two way radio equipment;

(d) Telephone swithchboard or console;

(e) Normal and Emergency power systems;

(f) Cable terminations; and

(g) Siren, vehicular door and traffic light controls.

(2) The alarm, supervising, and control equipment shall be arranged to facilitate continuous surveillance and ease of access by the operator. All equipment, with the exception of storage battery plants and emergency engine-generators, should be located in the same or in immediately adjacent areas to facilitate testing, maintenance, and surveillance. The radio antenna should be located as close as practicable to the transmitter and receiver.

c. Architectural--Structural. Where the center is located within a fire station and adjacent to the vehicle area, a substantial structural barrier should be provided to protect the alarm room from possible damage by fire trucks. Protection of relay and annunciating equipment from vibration due to vehicle door operations may require that sensitive equipment be shock-mounted and that large overhead doors be cushioned.

d. Mechanical. Mechanical systems criteria contained in paragraph 4d, above, shall be followed in the design of fire alarm control centers.

e. Electrical.

(1) Separate terminal cabinets and conduit systems should be provided for telephone cables, fire alarm cables, remote siren controls, and traffic-light controls.

(2) The use of exposed conduits, cable racks or trays, and surface raceways should be minimized.

(3) An electrical ground system meeting the requirements of NFPA codes for central station Grade A fire alarm centers shall be provided.

f. Fire Protection. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

10. SECURITY ALARM CONTROL CENTERS. These centers provide central station monitoring and recording of signals from remote perimeter intrusion detection systems; from protective alarms in vaults, rooms, or areas; from alarmed safes and file cabinets; and from watchman tour supervisory systems.

a. Location. Each center shall be located within a security area, preferably within or near the guard station which will respond to the alarms and supervisory signals.

b. Layout.

(1) These centers usually contain the following:

(a) Circuit supervisory testing and alarm panels;

(b) Alarm recording consoles;

(c) Two-way radio equipment;

(d) Telephone facilities;

(e) Normal and emergency power systems; and

(f) Cable terminations and interconnecting facilities.

(2) Centers shall be arranged so that all alarm communications and auxiliary power equipment necessary for continuous operation of the system are contained within the center or within contiguous areas having the same degree of physical security, including access control.

(3) Space shall be provided within the center for maintenance and for storage of spare units of line supervisory and alarm equipment.

(4) The initial and ultimate space and utility requirements of each center shall be determined in consultation with the DOE security authority having jurisdiction.

c. Architectural-Structural.

(1) Exterior walls should be windowless. For those security alarm control centers where windows are required for visual surveillance of areas outside the center, the windows shall be bullet resistant and of other characteristics as determined by the DOE security authority having jurisdiction. Personnel entryways shall include substantially-constructed doors, equipped with locks operable from within the centers. Where viewing ports or windows are provided in entryway doors, their size and other characteristics (e.g., one-way or wired glass) shall be as determined by the DOE security authority, in coordination with the DOE fire protection authority. Windows or other openings are not permitted in Class A fire doors.

(2) Required structural protection shall be provided against unauthorized personnel intrusion. Structural openings shall be kept to a minimum. The DOE security authority shall be consulted to determine requirements for structural protection of air intake and exhaust systems and other special security features.

d. Mechanical. Mechanical systems criteria in subparagraph 4d, above, and the criteria in Chapter V, "Mechanical Systems," as referenced therein, shall be followed in the design of mechanical systems for security alarm control centers. In addition, the heating, ventilating, and air conditioning (HVAC) systems serving these centers shall incorporate adequate air filtration features to protect against infiltration of aerosol and gas decapacitating agents, such as with the use of charcoal filters. Where a center is to be located in a multi-occupancy building, separate and secure HVAC systems should be provided. Where it is not technically or economically feasible to provide separate HVAC systems, at a minimum the center shall be protected by adequately filtering those portions of the building HVAC air supply systems serving the center. Filtration equipment shall be physically protected and located in secure areas.

e. Electrical. Design of the normal and emergency power system shall be in accordance with paragraph 4e, above, and in conformance with requirements in Underwriters Laboratories Standard 611, "Central Station Burglar-Alarm Units and Systems." The requirements of that Standard should be met by providing normal AC power, power rectifiers, storage batteries with trickle charger, and a standby generator. In addition to the lighting, as specified in paragraph 4e, above, essential illumination of the control center and entrance vestibule shall be provided from rechargeable, battery-powered lights arranged to automatically operate upon interruption of normal AC power.

f. Fire Protection. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

11. MISCELLANEOUS SPECIAL PURPOSE COMMUNICATIONS CENTERS. These are centers that provide equipment for control of warning and evacuation systems, public address and paging systems, television systems, and telemetry-type data-gathering systems. Automatic fire protection systems and portable fire extinguishers shall be provided in accordance with paragraph 4f, above. The initial and ultimate space and utility requirements for these centers shall be determined in accordance with paragraphs 3 and 4, above.

a. Warning and Evacuation Control Centers.

(1) These centers provide services for monitoring local, county, and State and/or Federal civil defense or other emergency-preparedness alert and warning systems and for transmission of warning and evacuation signals within DOE and DOE operating contractor offices and plant areas.

(2) The location and layout of each center will depend upon local condition and requirements. Centers will usually contain telephone facilities, equipment for transmitting signals and information, and radio facilities for coordination of emergency forces or to transmit supplementary information.

(3) Centers which utilize telephone and radio channels of communication shall generally be designed in accordance with criteria for Radio Control Centers in paragraph 8, above.

(4) Where the principal equipment provides local plant signaling systems over landlines, the criteria for Fire Alarm Control Centers in paragraph 9, above, shall generally apply.

(5) Reliable electrical power service shall be provided. Standby power supply may be provided from an emergency generator and/or a storage battery plant (e.g., with battery-inverter units to furnish AC power, in addition to DC power provided from the batteries for other uses), as appropriate for the loads to be served.

b. Public Address and Paging Centers.

(1) These centers provide services for initiating or receiving messages or alarm signals which require transmission over interbuilding or plant-wide systems employing landline or radio channels. Terminal devices may consist of loudspeakers, chimes, horns, lights, annunciators, or radio receivers.

(2) The transmitting facilities should be located in the area of the telephone switchboards or consoles, receptionist, vistor control point, or other principal user.

(3) The layout of these facilities will be dependent upon the availability of space and support facilities in existing communications areas where they may be located, and upon the size and complexity of the system. The criteria for Radio Control Centers, in paragraph 8, above, and/or Fire Alarm Control Centers, in paragraph 9, above, shall generally apply.

c. Television Control Centers.

(1) These centers provide services for monitoring and control of local television systems used by DOE or DOE contractors for administrative or operational purposes. They usually contain those facilities required for onsite operations using coaxial interconnection, microwave, or other point-to-point radio communication channels.

(2) The location of these centers shall be determined in accordance with the criteria for Radio Control Centers in paragraph 8, above.

(3) Special consideration shall be given to floor loading imposed by fixed and movable equipment, requirements for special lighting, and acoustical treatment.

d. Telemetry Control Centers.

(1) These centers provide services for monitoring and recording coded signals transmitted from telemetering devices located outside the center.

(2) The centers may employ landline, radio, microwave, or a combination of these communication channels.

(3) The location of the centers shall be determined by the functions to be performed (usually operational) and the principal users.

(4) The criteria for Radio Control Centers in paragraph 8, above, shall generally apply, with modifications, as necessary, if landline channels are used.

12. RADIO REPEATER STATIONS. These centers provide radio repeater services (transmitting and receiving) and are usually remotely located and unattended installations.

a. Location. The site selection shall be determined in accordance with applicable requirements of DOE 5320.1A, TELECOMMUNICATIONS: SPECTRUM DEPENDENT SERVICES, and advice and guidance obtained from the Headquarters' Office of Computer Services and Telecommunications Management.

b. Layout.

(1) Positioning of the station on the selected site shall be such as to assure the provision of all-weather vehicular and personnel access to the station building, the antenna(s), the standby generator plant, and fuel storage tank. Minimum risk of damage to the antenna structure and supporting guy lines from vehicular traffic and provisions for future expansion shall also be assured.

(2) Protective fencing with a locked gate or gates shall be provided where necessary to control access. The fence should be located inside the site perimeter to permit the use of weed-killing chemicals outside the fence line and on station property, to minimize the risk of a brush fire transferring to station property.

c. Architectural. The roof and exterior walls shall be insulated to minimize heating and cooling requirements. Exterior walls shall be windowless. Space shall be provided for maintenance activities, and for spare parts and tool storage.

d. Structural.

(1) These stations are frequently located at high elevations where it may be difficult to extend footings below the frost line. In these locations, the use of prestressed slab-on-grade construction should be considered. Unless roof-mounted antennas, masts, or towers are

to be used and necessitate flat-roof construction, the roof shall be pitched sufficiently to preclude excessive snow accumulation and to assure effective drainage.

(2) Where antenna towers, poles, or masts are to be located off the building, interconnecting cables shall be placed underground or adequately supported by a mesenger wire (or cable). The building end of the messenger wire shall not be secured to the bulkhead metal panel unless the panel and appurtenances are properly designed to support the load.

e. Mechanical.

(1) Heat gain from equipment shall be utilized, where practicable, to maintain the operating room ambient temperature during the heating season at not less than 40°F during normal operations. Auxiliary heaters capable of assuring an inside temperature of at least 40°F in the event of extremely cold weather or power outage to the radio equipment shall be provided. To provide additional heat during station maintenance periods, the auxiliary heaters should be capable of bringing the operating room temperature up to approximately 70°F within 30 minutes' time when the outside air is at the winter design temperature. The temperature in the emergency engine-generator room shall be maintained at not less than 40°F to protect storage batteries and to facilitate engine starting.

(2) During the cooling season, exhaust fans shall be used to provide sufficient ventilation to maintain safe internal station temperatures for the equipment in normal operation. Additional ventilating equipment should be provided for backup to the primary ventilating air system. Air-conditioning and/or dehumidification equipment may be installed, if necessary, to meet the environmental control requirements.

(3) Air intakes shall be located to assure ventilation of the radio equipment and shall be equipped with replaceable glass-fiber type filters. Thermostats should be positioned within the building so as to effectively sense the exhaust air temperature.

(4) A separate ventilation system shall be provided for the engine-generator room designed to provide adequate cooling in accordance with the equipment manufacturer's recommendations.

f. Electrical.

(1) Because radio repeater stations are usually in remote areas where the commercial power source may be subject to a greater incidence of outage than normal, the emergency power generator shall be selected and equipped to provide maximum reliability. In cold climates, special provisions for engine preheating (oil and/or engine coolant

heating) and the use of antifreeze coolants will be needed. A multicycle cranking limiter shall be provided to protect the engine starter and storage battery if the engine fails to start after a normal cranking period.

(2) Constant voltage transformers and/or special line filters may be required to meet the voltage stability requirements of the radio equipment, especially so for transistorized equipment.

(3) In addition to lightning arresters that shall be provided on the primary service, surge protection and electrostatic draining devices should be provided on the incoming secondary service at the point of building entry, particularly where the commercial power service is inherently subject to greater-than-normal lightning effects. All station equipment grounds, including those provided for the antennas, perimeter fence, electric power service, emergency generator service, building structure, surge protective and electrostatic drainage devices, cable trays, and installed equipment within the station building shall be bonded together. A separate ground may be provided for cathodic protection of an underground fuel tank(s) if such protection is required.

(4) Obstruction lighting for antennas, towers, and masts shall be provided, as required.

(5) Waveguides and outer sheaths of all coaxial antenna cables shall be connected to an electrically conductive bulkhead panel at the point of building entry and from there to two or more ground rods driven outside the building line and with bonding to the station ground grid.

g. Fire Protection. Automatic fire protection systems may be provided in accordance with paragraph 4f, above. Where water supply is not available or feasible for use in a sprinkler system, consideration should be given to the use of other systems (e.g., Halon, $CO_2$, or high expansion foam). Portable fire extinguishers shall be provided in accordance with paragraph 4f, above.

13. ANTENNA TOWERS, POLES, AND MASTS. These criteria are applicable to towers, poles, and mast which are to be erected as Government-owned structures at fixed telecommunications and alarm centers and radio repeater stations to support radio, television, and microwave antennas and reflectors. They are applicable, in part, to transportable (mobile) antenna structures. Criteria for antennas or reflectors, transmission lines, and other equipment to be mounted on the antenna structures, and the location, number, height, arrangement, and orientation of antenna structures, shall be determined in accordance with applicable requirements of DOE 5320.1A, TELECOMMUNICATIONS: SPECTRUM

DEPENDENT SERVICES, and as supplemented by the guidelines of Department of the Army Technical Manual TM-11-486-6, "Electrical Communications Systems--Engineering, Radio;" and advice and guidance obtained from the Headquarters' Office of Computer Services and Telecommunications Management.

a. Towers.

(1) Structural.

(a) Antenna towers shall normally be selected from standard types and sizes available from commercial tower manufacturers. They shall be designed in accordance with the National Telecommunications and Information Administration's "Manual of Regulations and Procedures for Federal Radio Frequency Management," NTIA Manual, Chapter 5. Towers not covered in the Manual shall be designed in accordance with Electronics Industries Association (EIA) Standard RS-22 and ANSI A58.1, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

(b) The design of towers shall be carefully checked to assure that adequate allowances have been made for maximum anticipated wind, snow, and ice conditions at the particular site when the tower is supporting the ultimate antenna, equipment, and other dead loads. Guyed towers should be selected for installation in areas subject to earthquake. The strength of antenna poles and masts shall be determined in accordance with the guidelines in Department of the Army TM-11-486-5, "Electrical Communications Systems--Engineering, Outside Plant, Wire." Towers, poles, and masts should have provisions for hoisting antennas and other equipment to the assigned levels.

(c) All towers and poles which persons will be required to climb shall be equipped with approved safeguards to protect workers from falling while climbing or working on the structures.

(d) Design of foundations for self-supporting and guyed towers shall be based upon the tower manufacturer's recommendation, adjusted to meet the ultimate tower loadings and local soil conditions.

(e) Foundations for guyed towers should usually have the shape of the tower base and should be oriented with one corner in the direction from which power, signal, and antenna cables will be extended. This configuration will permit conduits to be turned up on two adjacent sides of the tower and leave the remaining side(s) unobstructed. Anchors shall be in accordance with the recommendations of the tower manufacturer, adjusted to meet the ultimate tower loadings and local soil conditions. Guys should usually be furnished by the tower manufacturer and should come equipped with insulators or connectors arranged to eliminate mechanical and/or electrical resonance.

(f) Antenna towers shall be protected from mechanical damage and tampering. Wherever practicable, guyed towers and anchors shall be within a fenced enclosure subject to access controls prescribed by DOE safety and security authorities having jurisdiction.

(g) Tower foundations and guys shall be located clear of roadways and protected from vehicular damage by posts or other structural barriers.

(h) Overhead power lines, elevated water tanks, and similar adjacent structures should clear antenna towers, and their guys, if any, by at least their overturn distance (plus normal clearances for power lines).

(2) Electrical.

(a) All electrically grounded towers shall be protected with an air terminal, down conductor(s), and grounding system in accordance with the National Electrical Code. Ground conductors shall be brought to the tower corners, extended to the air terminal without intervening splices, and protected against mechanical damage. Metallic conduits shall not be used for the down conductors. Where it is necessary to enclose ground conductors within the tower foundation, separate ground conductors shall be brought to two legs of the tower and extended to the air terminal. The point of emergence of ground conductors from the foundation shall be sealed to prevent the entrance of moisture. The conductors shall be protected from mechanical damage at that point.

(b) Where guy supports are used, ground rods shall be installed at each anchor and connected to all guys terminating at that location.

(c) A ground counterpoise system shall be provided when required to meet the needs of the communications system.

(d) To the fullest extent practicable, the location and height of towers, poles, and masts shall be selected so as not to constitute an obstruction to navigable air space. Where this is not practicable, obstruction marking and lighting shall be provided in accordance with the FAA Handbook OAP 7460.0, "Obstruction Marking and Lighting." Part 77 of FAA Regulations (14 CFR 77) establishes standards for determining obstructions in navigable air space and the requirements for notifying the FAA Administrator of proposed construction or alterations.

b. Poles.

(1) The length and class of pole to be used shall be determined on the basis or required antenna height, depth of pole setting (for guidance, see Department of the Army Technical Manual TM 11-485-5), and the transverse load under maximum wind, snow, and ice loadings when supporting the ultimate weight of antenna(s) and equipment. The class of pole shall be determined by translating this maximum transverse load to an equivalent resistive moment based on loading 2 feet below pole top. Guys shall be installed, if necessary, for increased strength or margin of safety.

(2) Physical clearances, safety features, and grounding requirements shall be in accordance with the criteria described herein for towers.

c. Masts.

(1) Masts shall be designed in accordance with the criteria described herein for towers and poles, as applicable.

(2) Masts shall be mounted in a manner to permit installation, maintenance, and removal of antennas and fittings without undue hazard. Whenever practicable, masts should be so mounted as to permit lowering or tilting for maintenance.

(3) Reference drawings and specifications for a typical antenna mast suitable for supporting a VHF or UHF (of various types) and with mounting details are available on request from the Headquarters' Office of Computer Services and Telecommunications Management.

d. Hardened Antenna Facilities. Reference drawings and specifications for underground, hardened, and remotely controlled telescoping ("pushup") antenna structures and facilities for high frequency (HF) applications are available on request from the Headquarters' Office of Computer Services and Telecommunications Management.